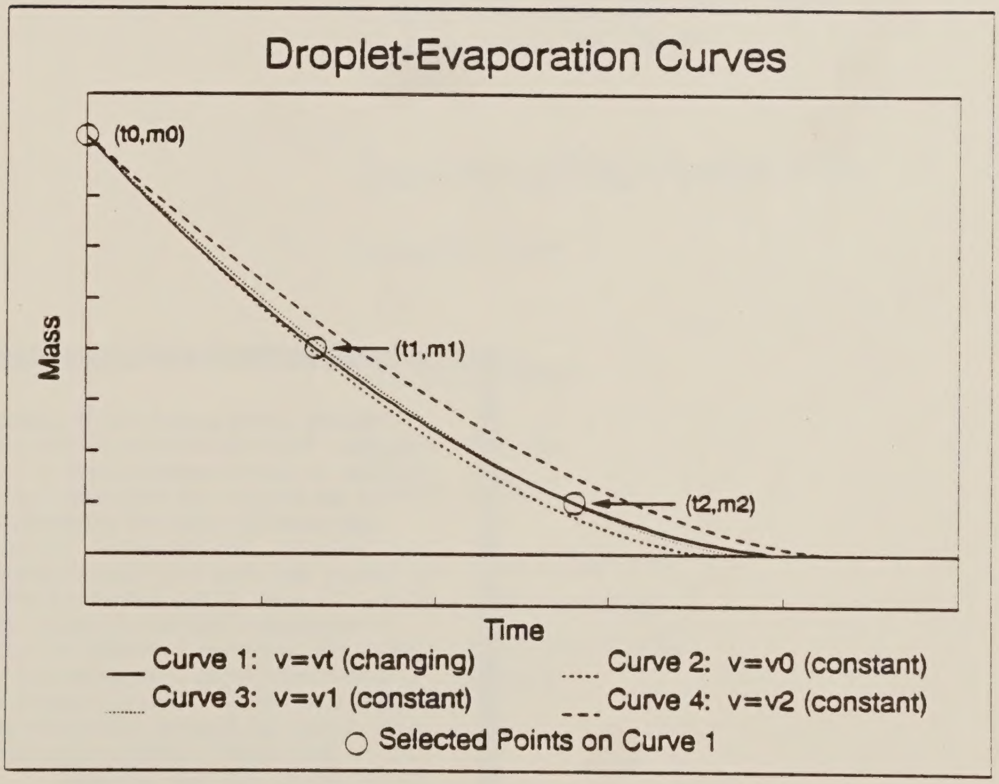
United States
Department of
Agriculture

Forest Service

Forest Pest
Management

Davis, CA

SPECIALIZED LABORATORY SUPPORT (TASK TA-31) DROPLET EVAPORATION



FPM 94-9
March 1994

Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

CAUTION: PESTICIDES

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SRI-APC-93-597-6819.7
March 1994

Specialized Laboratory Support
(Task TA-31)
Droplet Evaporation

Prepared by

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U.S. Army Dugway Proving Ground
Dugway, UT

Contract No. DAAD09-89-D-0005
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PREFACE

This project was initiated under the technical coordination of Robert Ekblad, USDA Forest Service (Ret.) in cooperation with Kenneth Chinn, U.S. Army Dugway Proving Ground (DPG). The USDA Forest Service (FS) and the industry-based Spray Drift Task Force shared a need for evaporation data on specified tank mixes. DPG had an existing contract with the Southern Research Institute as a source for evaporation determinations on a task order basis. The FS and SDTF joined with DPG to initiate this project recognizing the potential dollar savings in sharing Federal sponsored technology. While this joint venture did not realize its full potential due to technical challenges, it nevertheless was a success and clearly demonstrated the economies of Federal/Industry cooperation. The USDA Forest Service extends its appreciation to Kenneth Chinn and the U.S. Army and to the Spray Drift Task Force for cooperation and innovation in pursuit of spray droplet evaporation technology.

SRI-APC-93-597-6819.7

SPECIALIZED LABORATORY SUPPORT
TASK TA-31 -- DROPLET EVAPORATION

Data Report

to

U.S. Army Dugway Proving Ground
Dugway, Utah 84022-5000

Submitted by:

Bradford P. Gay
Donald P. Segers

Contract No. DAAD09-89-D-0005
Delivery Order No. 0007

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July 15, 1993
Project 6819.7

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SPECIALIZED LABORATORY SUPPORT
TASK TA-31 -- DROPLET EVAPORATION

1. INTRODUCTION

In accordance with the reporting requirements for Delivery Order No. 0007 under Contract DAAD09-89-D-0005 with the U.S. Army Dugway Proving Ground, this is the Data Report for Task TA-31 -- Droplet Evaporation. Under Task TA-31, Southern Research Institute (SRI) developed a novel experimental method for measuring the evaporation of small droplets. The test method that we developed was then used to measure evaporation rates for several test substances. This data report contains background information about the task, the task objectives, the scope of work for the task, the technical requirements for the experimental droplet-evaporation test method, a summary of the test-method development, a description of the droplet-evaporation test system, the test procedures, the results of the droplet-evaporation tests, and a limited discussion of those results from our perspective. We also include recommendations for further advancement of the droplet-evaporation test method developed at SRI.

2. BACKGROUND

The U.S. Department of Agriculture (USDA) Forest Service through the Technology and Development Center at Ft. Missoula (Missoula, MT) has been conducting a program to fully characterize the behavior of pesticide droplets generated by aerial spray applications. The goal of the Forest Service is to determine how the initial spray parameters (i.e., the controllable spray parameters) such as pesticide formulation, initial droplet size, and spray height affect the subsequent deposition of the pesticide droplets on the ground. To achieve this goal, the behavior of the pesticide droplets under applicable meteorological conditions must be known.

In addition to understanding how pesticide spray droplets will reach the ground, the USDA Forest Service and the Spray Drift Task Force (SDTF) require data that can be used to assess drift from spray applications of currently registered products as well as future products. That is, it is important to understand fully how spray droplets will behave so that the amount of pesticide reaching the intended target and the amount of drift can both be determined.

The most important process that must be quantified to characterize the deposition of spray droplets on the ground or the drift of spray droplets in the atmosphere is evaporation. Therefore, the USDA Forest Service and the SDTF formed an agreement with the U.S. Army Dugway Proving Ground to support a droplet-evaporation study. Dugway Proving Ground then awarded Task TA-31 to Southern Research Institute to develop a laboratory test method for measuring the evaporation of small droplets under different environmental conditions and then to generate droplet-evaporation rate data for specified test substances.

No. 0007 under Contract DAAD[illegible]-D-0005 with the U.S. Army Dugway Proving Ground, this is the [illegible] Report for Task TA-11 -- Droplet Evaporation. Under Task TA-11, Southern Research Institute (SRI) developed [illegible] method for measuring the evaporation of small droplets. The test method that we developed was then used to measure evaporation rates [illegible] substances. This report [illegible] background information [illegible] the task objectives, [illegible] the task, the technical requirements [illegible] of the test-method development [illegible] system, the test procedures [illegible] droplet evaporation test, a limited discussion of the [illegible] perspective. We also [illegible] recommendations for further [illegible] the droplet-evaporation test method developed at SRI.

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For reference purposes, Task TA-31 was designated by the Spray Drift Task Force as SDTF Study P91-001. Southern Research Institute designated the research effort as Project 6819.7.

3. OBJECTIVES

The main purpose of Task TA-31 was to obtain evaporation-rate time histories of small droplets of test substances with physical and chemical properties similar to those of actual pesticide formulations used for spraying forests or agricultural fields. It was desired that the evaporation rate data be obtained in a laboratory under controlled experimental conditions representative of those experienced by freely falling droplets exposed to typical meteorological conditions that would be encountered during pesticide spray applications. The laboratory approach to obtaining the desired evaporation data was chosen because it is difficult and expensive to obtain droplet-evaporation data in actual field tests. Before any experimental data could be generated, however, a laboratory test method (i.e., a new experimental method) had to be developed. Therefore, test-method development was another principal objective of Task TA-31.

4. SCOPE OF WORK

4.1 Overview

Task TA-31 was broken down into two phases: test-method development and droplet-evaporation testing. The test-method development was directed at designing, assembling, and evaluating a laboratory test system for measuring evaporation-rate time histories of small droplets under simulated environmental conditions that could be controlled and varied. The environmental conditions that were important were temperature and relative humidity (RH) and the relative air velocity that would result from the gravitational settling of a droplet. In connection with the development of the test system, test procedures were also developed. After development and evaluation of the complete test method, droplet-evaporation rates were measured for different-sized droplets of three test substances designated as range-finding solutions by the SDTF. These tests were conducted under different environmental conditions.

After the method-development phase of the research effort was completed, the droplet-evaporation testing of the SDTF range-finding solutions was conducted according to EPA FIFRA Good Laboratory Practice (GLP) standards as defined in 40 CFR Part 160, effective October 16, 1989.

4.2 Test Substances

Evaporation rate data were generated for the following test substances:

- World Health Organization (WHO) water
- 25% mixture (by volume) of Sulfur 6L with WHO water

- 50% mixture (by volume) of Thuricide 48LV with Milli-Q water

These test substances were identified by the STDF as range-finding solutions for droplet evaporation. The substances represent a range of physical properties that would be expected for actual pesticide formulations and were expected to exhibit significantly different evaporation rates.

We were originally supposed to test a 15% by weight mixture of n-propanol with WHO water, but this test substance was replaced by the Thuricide mixture.

The WHO water was Milli-Q water with an added hardness of 342 ppm. The Sulfur 6L was provided to SRI by the SDTF. The Thuricide 48LV was provided to us by Sandoz Agro, Inc., (Des Plaines, IL) at the request of the USDA Forest Service.

The Sulfur 6L was originally supposed to be tested as a 33% mixture by volume of the Sulfur 6L with WHO water but had to be tested as a 25% mixture because the 33% mixture would not form droplets on the glass filaments of the droplet-suspension device (DSD) that we used for testing. (See Section 7.2.1 for a description of the DSD.) The 25% mixture formed acceptable droplets. The Thuricide 48LV was originally supposed to be tested neat (i.e., as received) but had to be tested as a 50% mixture by volume of the Thuricide with Milli-Q water because the neat test substance could not be sprayed from the atomizer that we used for testing (see Section 7.2.2). The 50% mixture could be sprayed, and it formed acceptable droplets on the glass filaments of the DSD.

The test substances were prepared and handled according to the Study Protocol for SDTF Study P91-001 and according to SRI standard operating procedures (SOPs). The Study Protocol and the SOPs for the test substances included detailed information about the components of the test substances; receipt, handling, and storage of the test-substance components; mixing and handling of the test substances; storage of the test substances; return of unused test-substance components; and disposal of used test substances.

4.3 Test Parameters

The specified test parameters for the droplet-evaporation tests were as follows:

- Test substances: the three SDTF test substances described in the preceding section.

- Droplet diameter: three drop sizes in the range of 75 to 500 μm; the target drop sizes were 100, 250, and 400 μm.

- Temperature: three temperatures from 10 to 40 °C; the target temperatures were 15, 25, and 40 °C (59, 77, and 104 °F).

- Relative humidity: three relative humidities from 20 to 90%; the target relative humidities were 30, 60, and 90%.
- Air velocity: droplet terminal velocity or fixed air velocities selected to provide the required data.
- Replicates: three.

With regard to the drop size, temperature, and relative humidity for each droplet-evaporation test, the "target" values for these parameters in each test were the values that we tried to achieve. The actual drop size, temperature, and relative humidity in each test were experimentally measured. The measured values are described and discussed in Sections 9 and 10.

The target values given above for drop size, temperature, and relative humidity are the optimum values specified for the task except for the temperature of 15 °C, which we used instead of 10 °C. We used a target temperature of 15 °C instead of 10 °C because the test system that we assembled (see Section 7) could not produce a test temperature of 10 °C. There were also some tests with particular test parameters that could not be conducted because of other limitations of the test system or because of properties of the test substances. The tests that could not be performed are noted in Section 9.

The test parameter of air velocity is discussed in the next two sections (Sections 5 and 6).

5. TECHNICAL REQUIREMENTS

To achieve the objectives of Task TA-31, some important technical requirements were specified for the task. Continuous evaporation rate data for a droplet at an air velocity equal to the continuously changing settling velocity of the droplet were desired. In the event that continuous evaporation rates could not be obtained, data were to be obtained for a sufficiently large number of points in the time interval to enable the accurate fitting of the evaporation rate curve to the data. If a continuous change in air velocity during a test was not possible, we were to determine evaporation rates at fixed air velocities equal to 100, 80, and 60 percent of the initial droplet terminal velocity. (The initial droplet terminal velocity refers to the terminal velocity corresponding to the initial drop size). Each droplet-evaporation test was to be run for the time it would take the droplet to fall 100 m or for 30 min, whichever was shorter. The fulfillment of these technical requirements is discussed in the next section.

6. TEST-METHOD DEVELOPMENT

The first phase of Task TA-31 was the development of a reliable test method (i.e., test system and test procedures) to measure evaporation rates of small droplets. The test method had to provide meaningful droplet-evaporation data that could be used to predict the behavior of pesticide aerial sprays. The details of the test system and the test procedures that we

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TEST-METHOD DEVELOPMENT

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developed and then used to measure droplet-evaporation rates are described in Sections 7 and 8. This section of the data report summarizes the test-method development effort and covers basic theoretical considerations, the overall technical approach, and the most important experimental factors that had to be considered for the test method. Additional details of the test-method development were documented in the monthly progress reports for Task TA-31 and are not repeated in this data report.

Before describing the development of the experimental method that we used to measure droplet-evaporation rates, a brief discussion of evaporation rate data for droplets is appropriate. Figure 1 shows example (simulated) curves that depict the evaporation of a small droplet of a pure liquid (e.g., water). (The simulated curves in this report were generated using computer programs written by SRI outside of Task TA-31. These programs were based on published drop-evaporation theory. The simulated curves are also representative of known evaporation behavior for small droplets.) Each part of Figure 1 (1A, 1B, and 1C) shows two curves corresponding to the evaporation of a droplet under free-fall conditions (changing terminal velocity) and under stationary (or rest) conditions (no relative air velocity). (For a freely falling droplet or a stationary droplet, we assume that the droplet is spherical).

Figure 1A shows *droplet-evaporation curves* expressed as diameter versus time, while Figure 1B shows droplet-evaporation curves expressed as mass versus time. Figure 1C shows *droplet-evaporation rate curves*, which can also be referred to as evaporation-rate time histories. The curves in Figure 1C are based on evaporation rate expressed in terms of the change in mass per unit time. (The evaporation rates in Figure 1C are expressed as positive rates even though the change in mass versus time for an evaporating droplet is negative.) It is important to note that the curves in Figure 1C are the first derivative curves for the curves in Figure 1B; that is, each point along either curve in Figure 1C is equal to the slope of the corresponding curve in Figure 1B at the corresponding time.

The basic experimental technique selected to obtain droplet-evaporation data was the measurement of the mass of a droplet as a function of time using a microbalance. The droplet was to be suspended from a filament and exposed to controlled environmental conditions of temperature, relative humidity, and air velocity. In theory, this approach would produce droplet-evaporation curves analogous to those shown in Figure 1B. From the droplet-evaporation curves, droplet-evaporation rate curves could readily be obtained. However, there were initially two major problems with this approach that had to be addressed: (1) the mass of a single droplet was very low, and (2) the mass of a droplet could not be reliably measured during exposure to airflow. These problems are discussed further in the following paragraphs.

Under optimum conditions, the sensitivity of the microbalance that we used (see Section 7.2.3) was approximately 1 to 5 μg. Because the respective masses of 100-, 250-, and 400-μm droplets are 0.52, 8.2, and 34 μg (assuming a density of 1 g/mL), it was not feasible to suspend and weigh a single droplet with accuracy and precision. Thus, it was necessary to suspend multiple droplets simultaneously and to measure the total mass of the droplet

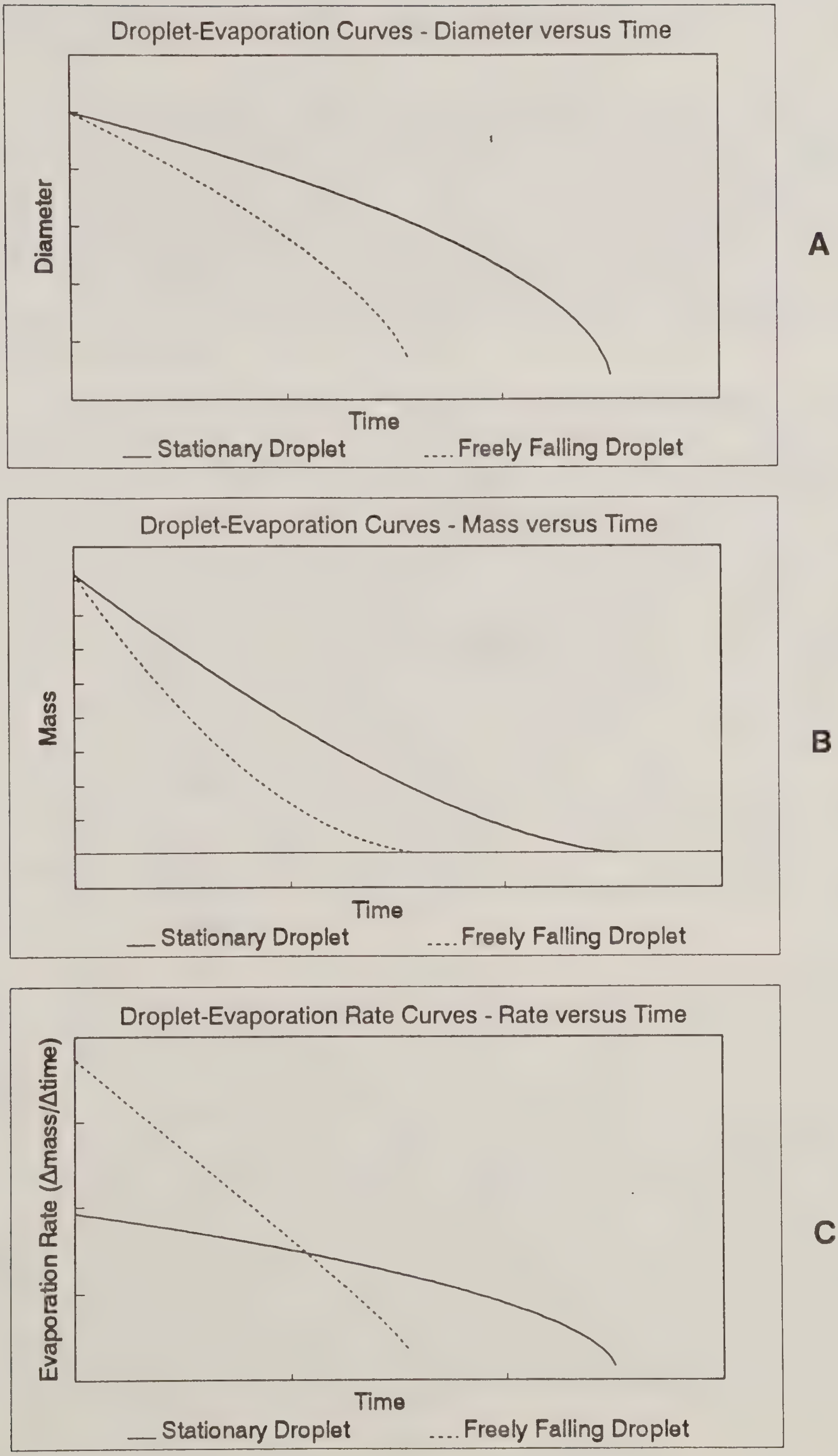


Figure 1. Example (simulated) evaporation curves and evaporation rate curves for a small droplet (pure liquid).

population as the droplets evaporated. This approach required that the droplets be as monodisperse in size as possible and that the number of droplets be measured.

The droplets were suspended on the droplet-suspension device (DSD) that is described in Section 7.2.1. The droplets in each test were generated using a pressurized atomizer that is described in Section 7.2.2. Several atomizers were evaluated, and the best one was selected to spray and "grow" droplets on the glass filaments of the DSD. The number of droplets in each test was measured by taking a photograph of the initial droplets with a camera fitted to a telemicroscope and by later counting the droplets in the photograph. Given the initial mass of the droplets, the number of droplets, and the diameter of the filaments (measured separately), the average initial drop size was calculated.

Using the microbalance to measure droplet evaporation, it was not possible to measure the mass of the droplets during exposure to airflow because of the drag on the droplets caused by the airflow. (See Section 7.2.1 for a description of the basic test-system design.) That is, it was not possible to measure a complete mass-versus-time droplet-evaporation curve as depicted in Figure 1B for a freely falling droplet. Figure 2 illustrates the basic approach that we initially selected to obtain the required data. Figure 2A shows a droplet-evaporation curve (simulated) for a freely falling droplet. Three selected points are shown on the curve with lines tangent to the curve at the three points. The slopes of the tangent lines are equal to the evaporation rates (r0, r1, and r2) at the three points. Figure 2B shows the droplet-evaporation rate curve that corresponds to the curve in Figure 2A. Along the curve in Figure 2B, three points are shown that correspond to the evaporation rates obtained from the tangent lines in Figure 2A. The experimental approach that we initially proposed was to determine three evaporation rates (e.g., r0, r1, and r2) during the evaporation of a droplet population. This was to be done by measuring the slope of the curve at three different points along the droplet-evaporation curve. The slope at each of these points would correspond to points along the droplet-evaporation rate curve as depicted in Figure 2.

The evaporation rate at three points along the droplet-evaporation curve for a droplet population was to be determined by measuring the change in mass over a known time interval at three different times during the course of evaporation. We planned to accomplish this by exposing a droplet population to the desired exposure conditions and by temporarily and quickly turning off the airflow at known times during exposure in order to measure the mass of the droplets. By selecting appropriate times to make the mass measurements, the slope at three points along the droplet-evaporation curve could be estimated. To obtain the most accurate data, the time interval over which the change in mass was measured would have to be as short as possible. In this case, the mass would have to be measured at six times during the course of evaporation. One of these times would be the initial mass of the droplets before any exposure. To make the approach simpler, the droplet-evaporation curve could be broken down into three time intervals, and therefore, the mass would only have to be measured at four times (including the initial mass) during the course of evaporation to estimate the evaporation rate during the three time

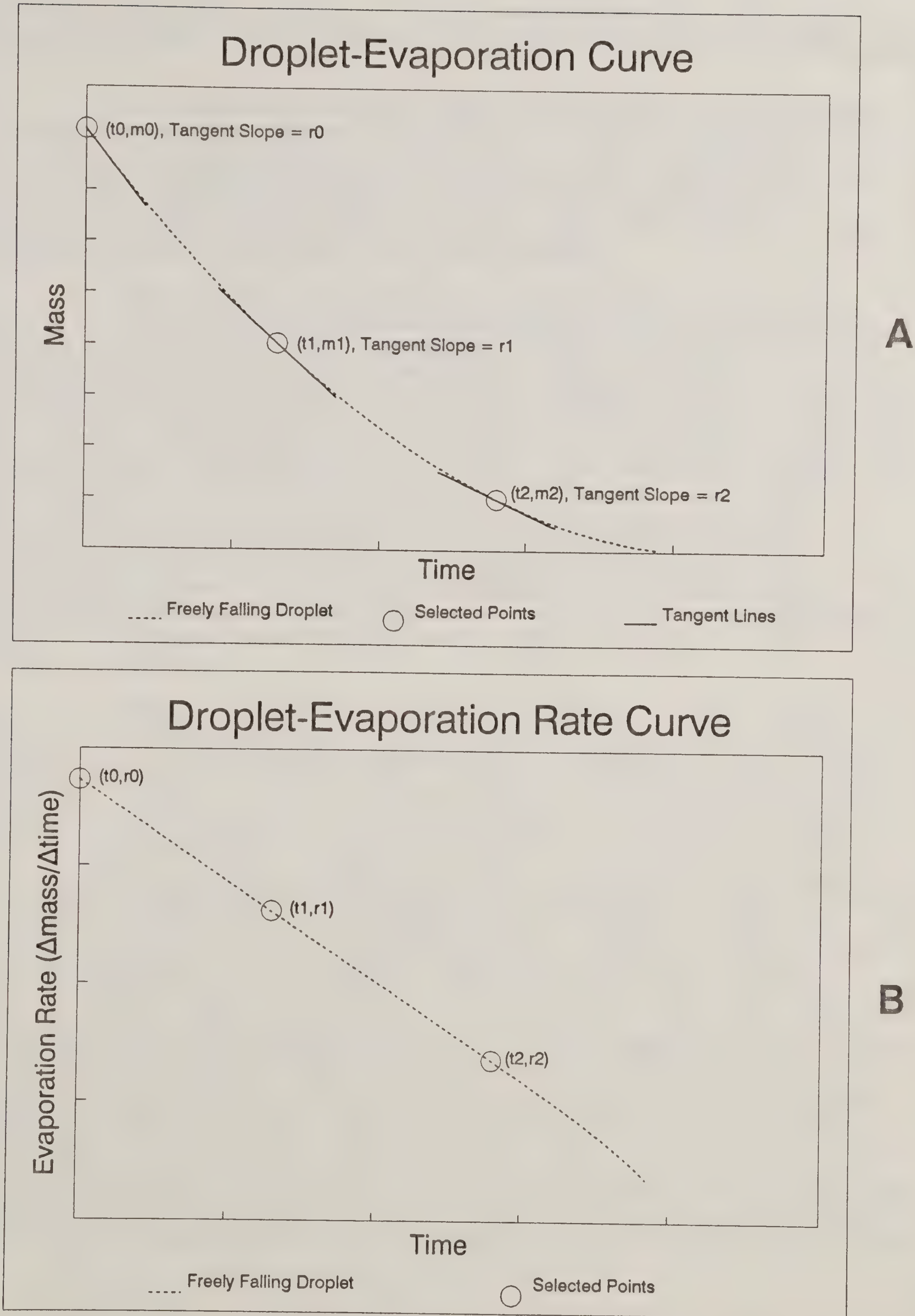


Figure 2. Example (simulated) evaporation curve and corresponding evaporation rate curve.

intervals. With this approach, all of the required data for a given set of exposure conditions would be obtained in one test (neglecting replicate tests).

Our initial experimental approach as described in the preceding paragraphs was based on two key assumptions: (1) that we would be able to vary the air velocity during the test to equal the changing terminal velocity corresponding to the evaporating droplets and (2) that we would be able to turn off the airflow and measure mass at times during the course of evaporation. Both of these requirements were found to be unfeasible, and therefore, the test method had to be further modified.

With regard to the technical requirements for the task (see Section 5), evaporation rate data were desired for droplets falling at their terminal velocities, or in our experimental approach, evaporation rate data were desired for suspended stationary droplets exposed to airflow at a velocity equal to the terminal velocity of the droplets. That is, sufficient data were desired to determine evaporation rate curves analogous to the curve for the freely falling droplet in Figure 1C. Because the terminal velocity of a freely falling droplet depends on the droplet size and because the size of a droplet decreases as the droplet evaporates, the terminal velocity for a droplet also decreases as the droplet falls and evaporates. We first attempted to design a test system in which the air velocity could be controlled and varied in real time to correspond to the changing size of the evaporating droplets. This experimental approach was soon found to be unfeasible because very sophisticated and costly equipment would be required. Therefore, we had to design the test method based on the use of a fixed air velocity in each test.

Figure 3 shows how air velocity is expected to affect droplet evaporation. Figure 3 contains four simulated droplet-evaporation curves. Curve 1 is for a freely falling droplet that is exposed to the relative air velocity (vt) as the droplet settles. Of course vt decreases as the droplet falls and evaporates. Curves 2, 3, and 4 show expected droplet-evaporation curves for three different constant air velocities. Also shown in Figure 3 are three selected points along Curve 1. The point (t0,m0) is the initial point on Curve 1. Curve 2 is based on a constant air velocity (v0) equal to the initial terminal velocity of the freely falling droplet. That is, Curve 2 is based on the terminal velocity corresponding to the point (t0,m0). Analogously, Curves 3 and 4 are based on fixed air velocities equal to the terminal velocities that correspond to the points (t1,m1) and (t2,m2). Curve 2 decreases faster than Curve 1, Curve 3 initially decreases slower than Curve 1 but then crosses Curve 1, and Curve 4 decreases slower than Curve 1 over the entire period plotted in Figure 3. The most important point to note about the curves shown in Figure 3 is that for each curve with a fixed air velocity, there is only one point along the curve where the evaporation rate equals the evaporation rate on Curve 1 for the same mass. That is, for a given mass, the slope of each curve with a fixed air velocity is equal to the slope of Curve 1 at only one point. The points where the evaporation rates (and curve slopes) are equal are the points where the both the masses and the corresponding air velocities are equal. With reference to Figure 3, Curves 1 and 2 have the same evaporation rates (slopes) at point (t0,m0) (where the air

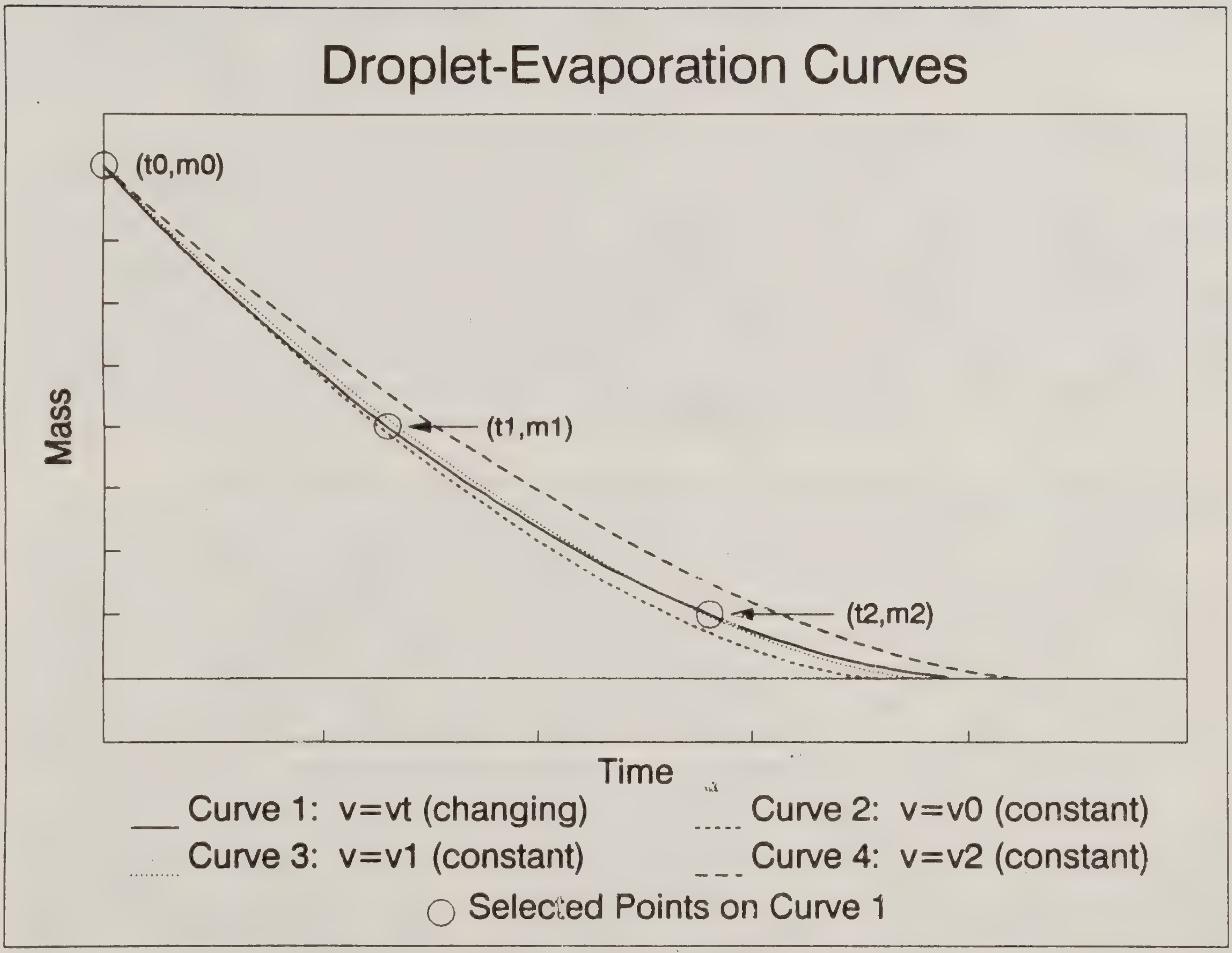


Figure 3. Example (simulated) droplet-evaporation curves for changing air velocity and fixed air velocities.

velocity equals v0); Curves 1 and 3 have the same evaporation rates when the mass equals ml (where the air velocity equals vl); and Curves 1 and 4 have the same evaporation rates when the mass equals m2 (where the air velocity equals v2).

Because of the relative properties of the droplet-evaporation curve for a freely falling droplet and of droplet-evaporation curves obtained with fixed air velocities, each curve obtained with a fixed air velocity theoretically can be used to determine one point along the droplet-evaporation rate curve for a freely falling droplet. Consequently, three droplet-evaporation tests with three different fixed air velocities would be required to determine three points on the droplet-evaporation rate curve for a freely falling droplet. (With three replicates of each test, nine tests would be required to generate one droplet-evaporation rate curve.)

Based on the preceding discussion, the fundamental experimental approach that we established for each droplet-evaporation test was to measure the evaporation rate of test-substance droplets (similar size) for a particular initial average drop size (target drop size) exposed to controlled environmental conditions including air velocity, temperature, and relative humidity. The evaporation rate was determined by measuring the change in mass of the droplets during a known evaporation period. The evaporation rate per droplet was calculated by dividing the total evaporation rate by the number of droplets. The air velocity for a test was selected to be a percentage of the terminal velocity corresponding to the target drop size.

The test procedure was designed to determine three evaporation rates corresponding to three different points along the evaporation rate curve for each target drop size. This was to be done by measuring the change in mass over three different (sequential) time intervals during the complete evaporation of the droplets. The time intervals would be selected so that the terminal velocity for the average drop size during each time interval would equal the fixed test air velocity. To determine each evaporation rate, the mass of the droplets would be measured immediately before and after exposure to airflow for a measured time. Because only one air velocity could be used in a given test, three tests with three different preset air velocities would be necessary to determine the evaporation rate during each of the three different time intervals. Using this approach, three evaporation rates on the droplet-evaporation rate curve could be determined for a given test substance and initial drop size (i.e., target drop size). The three evaporation rates would be determined for three fractional drop sizes of the initial drop size using three air velocities equal to the terminal velocities of the fractional drop sizes.

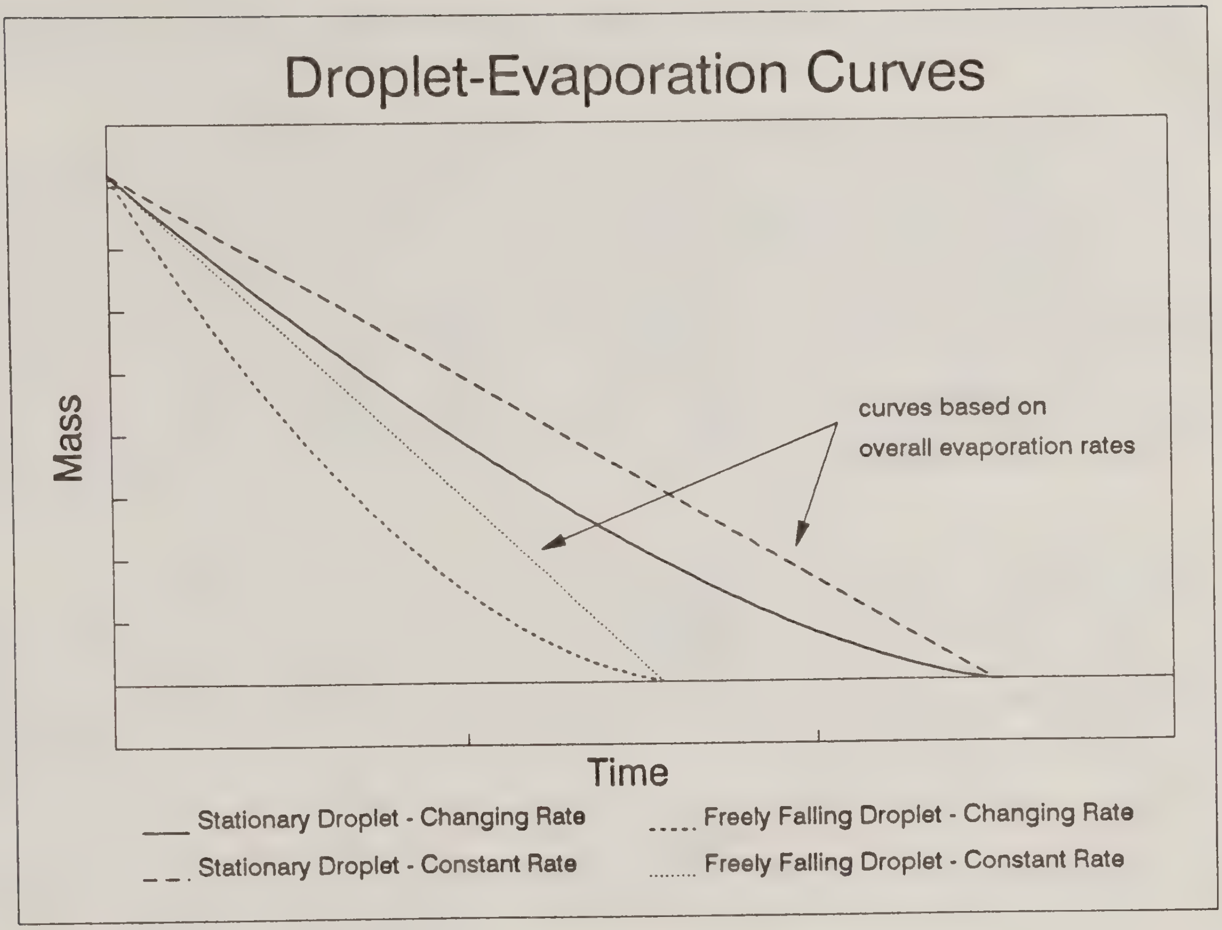
As already mentioned, the fixed air velocity in each test was chosen to be a percentage of the droplet terminal velocity corresponding to the target (initial) drop size. The fixed air velocities that we used were selected to be near 100, 80, and 60 percent of the terminal velocity of the target drop size. The actual values selected were convenient values corresponding to finite divisions on the analog readout of the anemometer that we used to measure air velocity. The anemometer is described in

Section 7.2.4, and the actual air velocities used in the tests are given in Section 9.4

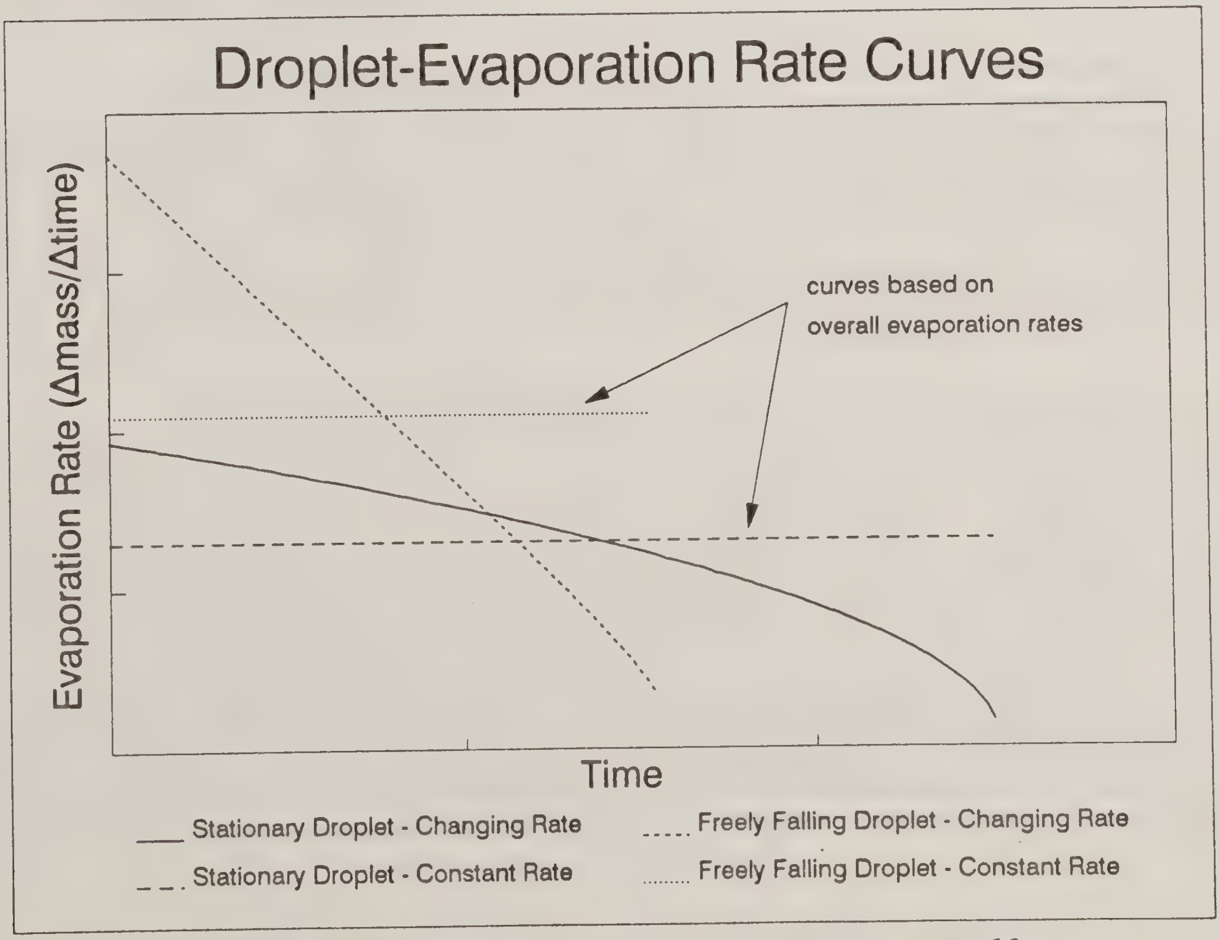
Although we worked out a possible test procedure to determine three points along an evaporation rate curve, the procedure did not work in practice because the substances that we tested evaporated too quickly for us to "catch" an interval during the overall evaporation of the droplets in a test. We therefore had to measure the *overall evaporation rate* for the droplets in each of three tests with three different fixed air velocities. This approach assumed that the measured overall evaporation rate for a given fixed air velocity approximated the evaporation rate for the corresponding fractional drop size of the target (initial) drop size. This approximation is valid if the evaporation curve (mass versus time) for a given air velocity is linear (i.e., if the evaporation rate for a given fixed air velocity is constant). The more curvature there is in the evaporation curve, the less valid is the assumption. The curves in Figure 3 suggest that the assumption is not valid because the mass-versus-time evaporation curves for fixed air velocities that are near the initial terminal velocity are expected to be similar to the curve for the freely falling droplet. Regardless of the validity of the assumption, however, theoretical predictions that we made (see below) and the actual test data for WHO water (see Sections 9 and 10) showed that, with other parameters being equal, the overall evaporation rates that we measured for a droplet population using different fixed air velocities were about the same in value and, moreover, should approximate the overall evaporation rates for freely falling droplets with the same initial drop size.

Given the assumption that the overall evaporation rate for a freely falling droplet can be approximated by the overall evaporation rate for a droplet exposed to airflow at a constant air velocity near the initial terminal velocity, Figure 4 shows how the overall evaporation rates relate to the real droplet-evaporation curves and the real droplet-evaporation rate curves. Figure 4A shows evaporation curves (simulated) for a freely falling droplet and a stationary droplet. Also shown in Figure 4A are linear evaporation curves that are based on the overall evaporation rates. If the true functional form of the droplet-evaporation curve is known, the overall evaporation rate could be used to estimate the curve. Figure 4B shows the droplet-evaporation rate curves that correspond to the curves in Figure 4A. As expected, the curves based on the overall evaporation rates are lines with zero slope because the corresponding curves in Figure 4A are linear. Note that for the freely falling droplet, the evaporation rate curve is almost linear. In this case, the overall evaporation rate and the initial mass of a droplet could be used to generate a good approximation to the real evaporation rate curve.

The other technical requirement for the testing was that each test be run for the time it would take the droplets to fall 100 m or for a maximum of 30 min. Because we could not predict a priori (with any certainty) how long it would take for the droplets to fall 100 m, we decided to run all tests until the droplets completely evaporated or for a maximum of 30 min. All three of the substances that we tested evaporated in less than 30 min, and therefore, most of the tests were run until the droplets completely evaporated. However, we allowed many of the tests to run a few minutes after



A



B

Figure 4. Example (simulated) curves to explain overall evaporation rates.

the droplets stopped evaporating to establish a baseline for the measured mass, especially when the test substance had some nonvolatile components.

To summarize the capability of the test method that we developed, an overall droplet-evaporation rate can be measured (using a fixed air velocity) that estimates the overall evaporation rate of a freely falling droplet. Because the droplets for the test substances evaporated so quickly, the method was not able to determine an actual droplet-evaporation rate curve. Such a curve could be fitted to the overall evaporation data if the curve form is accurately known. In practical use, however, it may be more than adequate to assume a linear evaporation rate curve based on the overall evaporation rate. A linear evaporation rate curve could be used to predict the evaporation of a freely falling droplet. Given the initial drop size and the overall evaporation rate, the simple lifetime of a droplet could also be calculated.

Using the test method that we developed, overall evaporation rate versus initial drop size was measured for each of the three test substances under different exposure conditions. Because the test substances were mixtures, it is important to note that the evaporation rate for a particular drop size depended on the composition of the droplet, which changed with evaporation; therefore, the evaporation rate for a given drop size must be associated with both the initial size and the initial composition of the droplet. For example, the evaporation rate of a 100-μm droplet (initial size) of a particular test-substance mixture would be expected to differ from the evaporation rate of a 100-μm droplet that resulted from the evaporation of a larger droplet (larger initial size) of the same test-substance mixture with the same initial composition.

After the complete test system was designed and assembled, and after initial test procedures were developed, the test method was evaluated by obtaining preliminary droplet-evaporation data using Milli-Q water. The results of these preliminary (non-GLP) tests showed that the test method did provide reliable droplet-evaporation data. The results of the Milli-Q water tests were reported in the Eighth Monthly Progress Report (dated October 9, 1992) for Task TA-31. In that report, the Milli-Q water data were compared to theoretical predictions for the evaporation of water droplets and were shown to be reliable.

Predicted droplet-evaporation curves in the Eighth Monthly Progress Report also indicated, for a 250-μm droplet, that a constant air velocity near the drop's initial terminal velocity produces an evaporation curve similar to that for a freely falling droplet, which is exposed to a changing air velocity equal to the drop's changing terminal velocity. That is, a fixed air velocity near the terminal velocity can be used experimentally to determine the evaporation rate under free-fall conditions. Also, different fixed air velocities ranging from 67% to 94% of the terminal velocity for a 250-μm droplet were predicted to give very similar evaporation curves. The droplet-evaporation tests that we conducted with WHO water were run using three different fixed air velocities. The data for these tests (see Sections 9 and 10) also supported the prediction that air velocity was not a major parameter affecting evaporation rates as long as the air velocity was near the

[illegible] droplet evaporation [illegible]
[illegible] test substance [illegible] components.

To summarize the capability of the test method [illegible] developed, [illegible] overall droplet-evaporation rate [illegible] measured (using [illegible] velocity) [illegible] estimates [illegible] overall evaporation rate [illegible] falling droplet [illegible] the droplets [illegible] the [illegible] substances evaporated too quickly, the method was not able to [illegible] droplet-evaporation rate [illegible] a curve could be fit [illegible] overall evaporation [illegible] curve form [illegible] accurately [illegible]. In [illegible] however, [illegible] than accurate to assume a linear evaporation [illegible] based on the overall [illegible]. A linear evaporation [illegible] could [illegible] used to predict [illegible] evaporation of a freely falling droplet. Given the initial [illegible] and [illegible] overall evaporation rate, the simple linear [illegible] [illegible].

[illegible] the test [illegible] that we have [illegible] evaporation [illegible] initial drop size was [illegible] differing [illegible] conditions [illegible] substances were [illegible] important [illegible] that [illegible] drop size [illegible] evaporation; therefore, [illegible] associated with both the initial [illegible] initial [illegible]. For example, the [illegible] initial sizes [illegible] a particular [illegible] substance [illegible] differ from the evaporation rate [illegible] the evaporation [illegible] larger droplets (larger initial size [illegible]) the same initial [illegible].

After the [illegible] our initial test procedures [illegible] test method [illegible] evaluated by [illegible] preliminary droplet-evaporation [illegible] using [illegible] water. [illegible] of these preliminary [illegible] showed that the test method did [illegible] evaporation rate. The results of the [illegible] reported in the Eighth Monthly Progress Report [illegible] Task IX-1. In that report, the [illegible] predictions for the evaporation of water [illegible] [illegible] able.

Predicted droplet evaporation curves in the Eighth Monthly [illegible] report also indicated [illegible] 250-µm droplet that [illegible] near the drop's initial [illegible] velocity produces [illegible] evaporation similar to that for a freely falling droplet, which is exposed to [illegible] equal to the drop's changing terminal velocity. Thus [illegible] near the terminal velocity [illegible] used experimentally [illegible] evaporation rate under free-fall conditions. [illegible] from 6% to 74% of the terminal velocity for a [illegible] give very similar evaporation curves. The [illegible] conducted [illegible] were run using [illegible] these tests (see Sections [illegible] was not a major [illegible] the air velocity was near the [illegible]

initial terminal velocity. This contention simplified subsequent testing significantly because only one fixed air velocity had to be used for the tests following the WHO-water tests.

After we finalized the test method to be used to measure droplet-evaporation rates for the SDTF range-finding solutions, we spent considerable time writing numerous detailed standard operating procedures that were required before conducting the droplet-evaporation tests.

Another approach to measuring droplet evaporation in the study was considered and should be mentioned. We looked at the possibility of using the camera and telemicroscope that were referred to above to take sequential photographs of the droplets as they evaporated so that the droplets in the photographs could be digitized to determine drop size as a function of time. The main advantage of this possible method was that the droplets could be photographed while exposed to airflow to generate continuous diameter-versus-time data. Regardless of the potential advantage, the use of photography to determine diameter-versus-time data for the droplets was not feasible because even with the telemicroscope, the droplets in the developed photographs were not big enough to digitize accurately. Enlargement of some photographs produced fuzzy images, and the cost of enlarging all of the photographs was prohibitive.

7. DROPLET-EVAPORATION TEST SYSTEM

7.1 Summary

The droplet-evaporation test system was custom designed and built by Southern Research Institute for determining the evaporation of small droplets of various "liquid" test substances that could be pure liquids, solutions, or suspensions. Using the test system, the droplet-evaporation rate during a given evaporation period was determined for a population of droplets of similar size by measuring the mass loss versus time. Given the measured initial total mass of the droplet population, the number of droplets, and the change in mass during the known evaporation period, the average evaporation rate per droplet was determined for the evaporation period. The droplet evaporation was measured under different, controlled experimental conditions of temperature, relative humidity (RH), and fixed air velocity.

7.2 Description of Test System

7.2.1 Overview

Figure 5 shows a schematic diagram of the droplet-evaporation test system. The principal components of the test system that are shown in Figure 5 were

- an electronic microbalance,
- an airflow system,

initial terminal velocity. This correction is little [illegible] significantly because only the final air velocity [illegible] following the WHO-[illegible] tests.

After we familiar[illegible] the test method [illegible] evaporation rates for the SNTK [illegible] standing [illegible] the wetting [illegible] decaying [illegible] required before connecting the drop[illegible] evaporation tests.

Another approach [illegible] considered [illegible] camera and [illegible] photographs of the droplets [illegible] photographs could be digitized [illegible]. The [illegible] advantage of this possibility [illegible] photographed while exposed to all [illegible] the data. Recyclable [illegible] determine diameter-versus-time data [illegible] even with the [illegible] of the [illegible] not big enough to [illegible] produced fuzzy images and the cost of [illegible] prohibitive.

7. DROPLET EVAPORATION TEST

7.1 Summary

The droplet evaporation test [illegible] system designed and built by Southern Research [illegible] of [illegible] droplets of various "liquid" [illegible] that could be pure liquids, solutions, or suspensions. Using this test system the droplet-evaporation rate [illegible] gives [illegible] determine [illegible] population of droplets of similar size by measuring the mass [illegible] the measured initial total mass of the [illegible] the number of droplets and the change in mass during the [illegible] average droplet [illegible] per droplet is determined [illegible] droplet evaporation was [illegible] under different [illegible] experimental conditions of temperature, relative humidity, and fixed air velocity.

Description of Test System

Figure [illegible] shows a schematic diagram of the droplet-evaporation test. The principal components of the test system that are shown in [illegible]

[illegible]ronic microbal[illegible]

[illegible] System

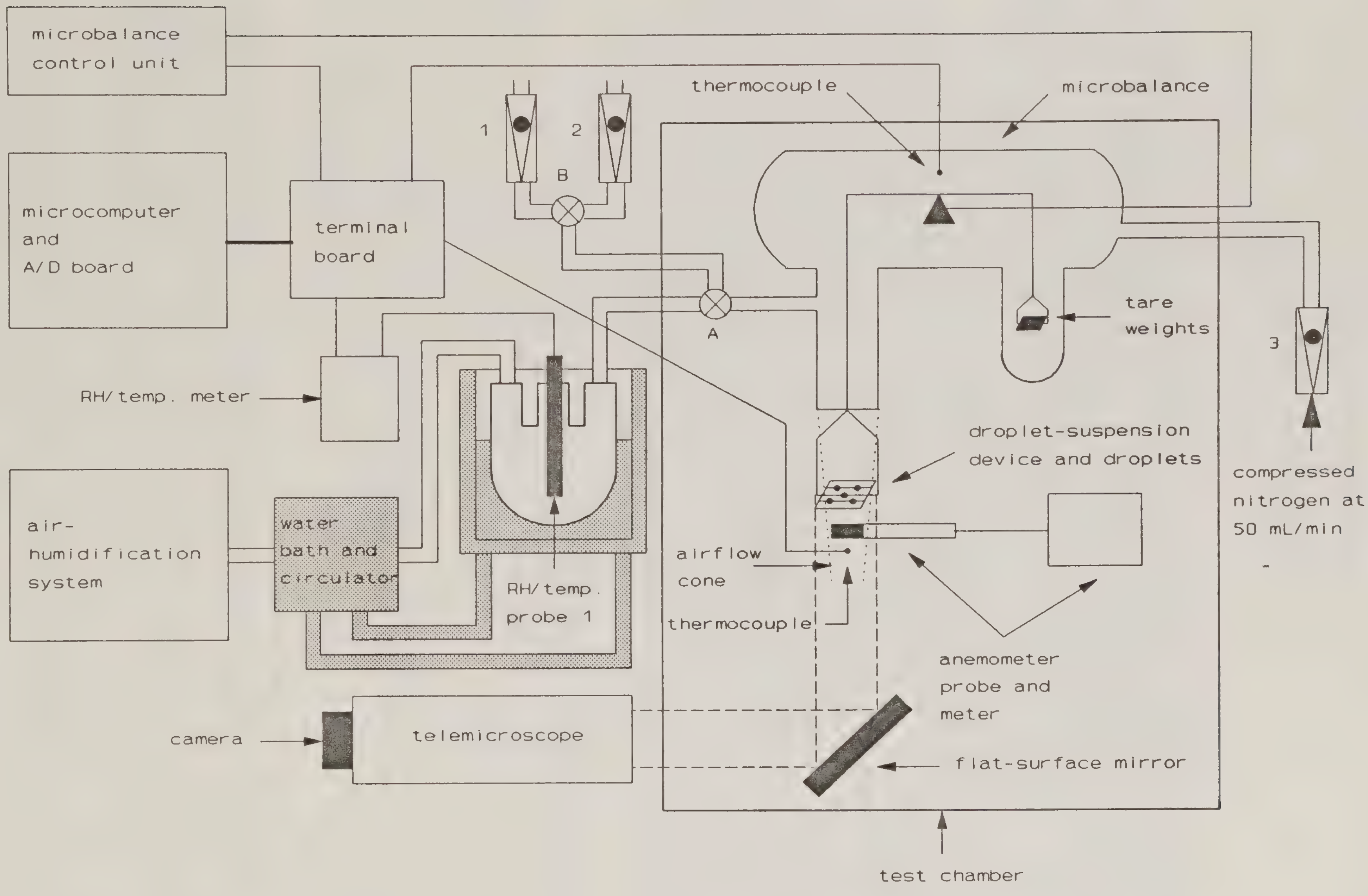


Figure 5. Schematic drawing of the droplet-evaporation test system.

- an air-humidification system,
- a temperature-control system,
- a photographic system, and
- a data-acquisition system.

There was another important subsystem of the droplet-evaporation test system that is not shown in Figure 5 -- the droplet-spraying apparatus, which primarily consisted of an atomizer and related apparatus for spraying a population of small droplets onto the filaments of a droplet-suspension device (DSD). A very simplified drawing of the DSD is shown in Figure 5, and Figure 6 shows a photograph of one of the DSDs that we used.

The DSD was specially designed and fabricated for this project by SRI to suspend multiple droplets so that they could be weighed with the microbalance. The DSD consisted of a piece of aluminum that was 3/4-in. by 3/4-in. square and 1/16-in. thick glued to a No.-1566 open nichrome stirrup from Cahn Instruments, Inc., (Cerritos, CA), which was the manufacturer of the microbalance (see Section 7.2.3). The piece of aluminum had a 1/2-in. diameter hole in the middle across which thin glass filaments were laid. The glass filaments lay in 13 very fine and evenly spaced grooves that were machined into the surface of the aluminum across the width of the piece. With the aid of a microscope, the filaments were laid across the hole in the aluminum piece using high-precision tweezers. The grooves allowed the filaments to be positioned until they were glued in place with fingernail polish. The aluminum piece also had numerous small holes drilled into it around the large center hole to reduce the mass of the DSD.

We made several DSDs for use. The glass filaments for the DSDs were selected from a supply of calcium-metaphosphate filaments made at SRI prior to this project. The filaments for each DSD were selected under the microscope to have as close to the same diameter as could be determined visually with the microscope. The average filament diameter for each DSD that we made and used was measured as described in Section 8.7. We purposely made several DSDs with different average filament diameters to suspend droplets of different diameters. The droplet-spraying apparatus (see the next section) was designed so that droplets of approximately uniform size were sprayed only onto the filaments of the DSD and not onto any other part of the DSD.

As shown in Figure 5, the microbalance and the DSD with the suspended droplets were contained in a test chamber. The test chamber was a large acrylic box with a small hinged door on the front of the box for easy access to the apparatus inside the test chamber. The main purpose of the test chamber was to protect the microbalance and suspended drops from airflow in the laboratory, but the chamber was also needed to help control the temperature and relative humidity for the tests.

As previously described, the droplet-evaporation test method involved the measurement of the evaporation rate of a population of droplets

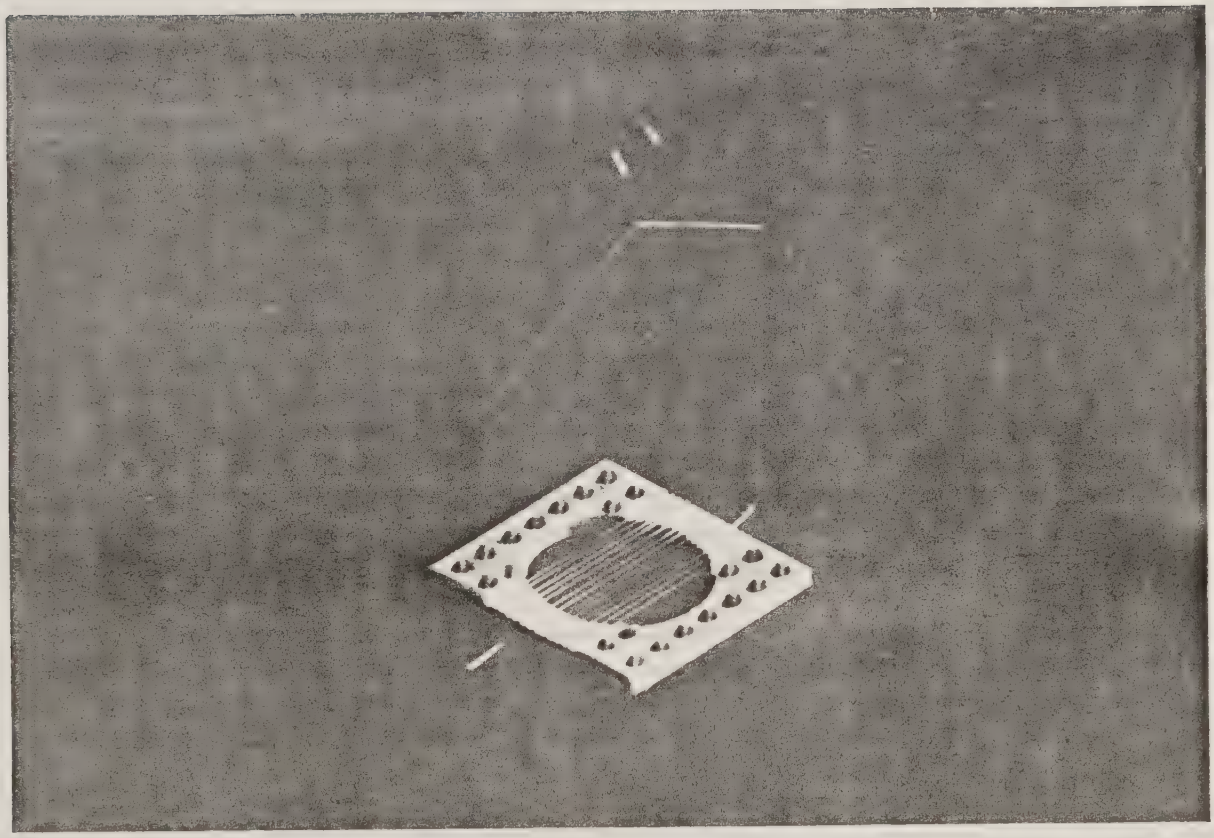


Figure 6. Droplet-suspension device (DSD).

that were exposed to airflow at a controlled temperature, relative humidity, and constant air velocity. The evaporation rate was determined by measuring the change in mass of the droplets during a known exposure period. The droplet-evaporation test system that is shown in Figure 5 and its various subsystems were designed to measure evaporation rate under the required conditions. To summarize the test system and its operation, droplets were sprayed onto the filaments of the DSD, which was then suspended from the hangdown wire of the microbalance. Humidified air flowed from the air-humidification system and was primarily controlled in temperature by the water bath/circulator and secondary water bath shown in Figure 5. The airflow could be directed (using Valve A) toward the suspended droplets or through one of two rotameters as selected by Valve B. Dry nitrogen was flowed at a low flow rate through the microbalance vacuum bottle to keep the microbalance dry. The mass of the droplets was measured with the microbalance before and after exposure to airflow, which was controlled by Valve A.

The velocity of the airflow at the drop location depended on the total flow rate of the air stream through the system. The air stream was generated by a pump and was controlled with needle valves in the humidification system. The velocity of the airflow at the drop location was measured with an anemometer. The temperature and relative humidity of the air stream were measured inside the flask that was placed in the secondary water bath. The temperature of the airflow at the drop location was measured with a thermocouple and was used to calculate the relative humidity at the drop location.

The number of droplets was photographed using the camera and telemicroscope that were positioned to view the suspended droplets from below via the mirror. To automate data collection, most of the measuring devices in the test system were interfaced to a computer as shown in Figure 5.

The remainder of Section 7 is devoted to describing in detail the components of the droplet-evaporation test system, the operation of the system components, and the calibration of the various measuring devices.

7.2.2 Droplet-Spraying Apparatus

The droplet-spraying apparatus was comprised primarily of an atomizer (chromatographic sprayer, Part No. 2753-L10; Thomas Scientific, Swedesboro, NJ); a stainless-steel, three-way ball valve; a stainless-steel, two-way ball valve; a rotameter; a nitrogen tank with a dual-stage regulator and a regulating valve; and appropriate tubing to connect the various pieces of apparatus. The atomizer, which was located inside the test chamber, was connected by Tygon tubing through a hole in the test-chamber wall to one of the "outlets" of the three-way ball valve, which was attached to the outside of the test chamber. The nitrogen tank was connected to the "inlet" of the three-way valve, and a two-way ball valve was attached to the other "outlet" of the three-way valve. With this arrangement, the three-way valve could be turned to direct nitrogen flow either to the atomizer or to the two-way valve. When the two-way valve was closed, the three-way valve served as the on/off valve for the sprayer. The rotameter was connected to the other side of the

[illegible] s were exposed [illegible] airflow at controlled temperatures, relative humidity and [illegible] velocity. The evaporation rate was [illegible] of [illegible] droplets [illegible] substrates were designed [illegible] conditions. To [illegible] the test system [illegible] sprayed onto the [illegible] hanged [illegible] wire of the [illegible] humidifier [illegible] system and was [illegible] bath/circulator and secondary [illegible] be directed (using Valve A) [illegible] two instruments [illegible] Valve B [illegible] rate through the [illegible] tube of the [illegible] measured with [illegible] which was [illegible]

The [illegible] of the airflow [illegible] total flow rate [illegible] generated [illegible] humidifier system [illegible] measured [illegible] streams were measured inside the [illegible] bath. The [illegible] of the air [illegible] thermocouple [illegible] was used to calculate [illegible] relative [illegible] location.

The [illegible] telescope [illegible] via the mirror [illegible] the test system [illegible]

The [illegible] section 7.1 [illegible] components of the droplet [illegible] test system [illegible] components and the [illegible] various [illegible]

7.2.2 Droplet Spraying System

The droplet spraying apparatus was comprised primarily of an atomizing air sprayer, Part No. [illegible] stainless steel [illegible] a stainless-steel three-way ball valve [illegible] valve; a rotameter; a nitrogen tank with a dual stage [illegible] a three-acting valve, and appropriate tubing [illegible] The atomizer, which was located inside [illegible] through a hole in the test [illegible] the three-way ball valve, which [illegible] The nitrogen tank was connected to the [illegible] valve was attached to the [illegible] arrangement, the three-way valve could be [illegible] the atomizer or [illegible] way valve [illegible] to the other side of the

two-way valve so that the flow rate of the nitrogen stream could be checked and set prior to the use of the atomizer.

The atomizer was fixed in position at one end of a specially designed spray box to contain the over-spray from the atomizer. (The spray box was also located inside the test chamber.) Using the atomizer, droplets were sprayed through a hole in a plastic "wall" onto the filaments of the DSD. The plastic wall, which we called the DSD holder, was approximately perpendicular to the exit of the atomizer. The bottom of the DSD was held against the hole in the DSD holder (i.e., towards the atomizer spray) on the side of the DSD holder opposite the atomizer. There was a simple fixture on the back of the DSD holder to rest the DSD in a reproducible location. The hole in the plastic wall was sized so that the droplets would be sprayed only onto the filaments of the DSD and not onto any other part of the DSD. The side of the plastic wall facing the atomizer caught the over-spray from the atomizer, which ran down and collected in the bottom of the spray box. The plastic wall could be positioned at different distances from the atomizer to optimize the formation of droplets on the DSD filaments.

Another part of the droplet-spraying apparatus was a suction device for the removal of excess test substance or rinse water from the atomizer. This device consisted of a short piece of 1/16-in.-O.D. Teflon tubing connected to a water aspirator/trap via 1/8-in.-O.D. Teflon tubing. An electrical switch was also set up to send a signal to the data-acquisition system to mark the time at which the drop spraying was stopped.

7.2.3 Electronic Microbalance

The microbalance incorporated into the droplet-evaporation test system was a Model C-2000 Recording Balance from Cahn Instruments, Inc., (Cerritos, CA). The microbalance was mounted inside a glass vacuum bottle that had a specially designed and fabricated open-end glass hangdown tube on the sample side and a shorter closed-end glass hangdown tube on the tare side. The hangdown tube on the sample side was vacuum-jacketed to insulate the air stream flowing down through the tube. The air stream entered the sample-side hangdown tube through a side-arm port that had a gradually increasing inner diameter to limit the velocity of the incoming air stream against the hangdown wire. The lower 6-in. portion of the hangdown tube was straight with a constant inner diameter of 15 mm. Based on the inner dimensions of the hangdown tube and on the flow rates that we used in the tests, the airflow exiting the hangdown tube should have been laminar (Reynolds Number < 2000). (Preliminary flow studies with dry-ice vapor through a similar hangdown tube showed that a laminar-flow air plume exited the tube and extended past the location of the droplets when suspended.)

The hooked end of the microbalance hangdown wire from which the DSD was suspended extended just past the end of the hangdown tube so that the DSD could be quickly suspended. When the DSD was hung from the hangdown wire it typically would swing back and forth for a while until it came to rest. To limit and to damp the swinging of the hangdown wire, thin stainless-steel cross wires were attached over the end of the hangdown tube. These wires were very fine so that they would not affect the airflow out of the tube, but they

did allow mass measurements to be made sooner after the DSD was hung. When the hangdown wire and the DSD stopped swinging, the cross wires did not touch the hangdown wire and, therefore, did not affect the mass measurement.

When the DSD was hung from the microbalance hangdown wire, the filaments of the DSD were perpendicular to the airflow exiting the hangdown tube. The airflow passed through the hole in the DSD and through the series of filaments that were fixed across the hole in the DSD.

7.2.4 Airflow System

As shown in Figure 5, the main airflow system included the components of the air-humidification system (see Section 7.2.5), several airflow lines, several valves, two rotameters, and a three-neck flask in which the temperature and relative humidity of the air stream could be measured. The system flow lines included a heat-traced Teflon flow line from the humidification system to the water bath; a coiled copper flow line in the water bath; a copper flow line from the water bath to the three-neck flask; a copper line from the flask to Valve A, which was a Nalgene three-way stopcock; Tygon tubing from Valve A to the glass hangdown tube of the microbalance; and Tygon tubing from Valve A to Valve B, which was a Nalgene three-way stopcock connected to Rotameters 1 and 2. (Figure 5 shows Rotameters 1 and 2 outside of the test chamber, but the rotameters had to be moved inside the test chamber to keep them warm enough to prevent condensation inside the rotameters when tests were conducted at 40 °C and high humidity.) The flow lines were insulated as needed.

Valve A was used to direct the flow of air through the hangdown tube of the microbalance or to bypass the hangdown tube and direct the airflow through Valve B. Valve B was used to direct the airflow through one of two rotameters. These rotameters were used to set approximately the system flow rate prior to a droplet-evaporation test. Rotameter 1 measured high flow rates and Rotameter 2 measured low flow rates. The total flow rate through the test system was controlled by the air-humidification system as described in the next section.

A secondary flow system is also shown in Figure 5. To keep the microbalance vacuum bottle dry during the droplet-evaporation experiments, dry compressed nitrogen was flowed into the vacuum bottle at a very low flow rate (50 mL/min). This nitrogen flow mixed with the humidified air stream in the hangdown tube attached to the vacuum bottle but made up less than 5% of the combined air stream.

Of course, the air velocity in each test depended on the total flow rate through the test system. The total flow rate was measured with the various flowmeters to preset approximately the air velocity for the test. The actual air velocity was measured with an anemometer. The anemometer that we used was a Kurz Series 490 Mini-Anemometer (Kurz Instruments, Inc., Monterey, CA). The Kurz anemometer was an electronic velocity meter with a probe containing a small thermal velocity sensor and a small temperature sensor. The end of the probe containing the sensors was small enough to be easily positioned in the air stream exiting the glass hangdown tube. Although

the [illegible] and the [illegible]. When the hangdown air [illegible], it [illegible], did not [illegible].

When the DCD [illegible] filaments of the DCD were [illegible] tube. The airflow passed through the hole in [illegible] of filaments that [illegible] fixed across [illegible] hole in [illegible]

7.3.4 Airflow System

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[illegible]

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Water bath [illegible]
Copper line from [illegible]
T gon tubing [illegible]
Tygon tubing from [illegible]
Connected [illegible]
The test chamber [illegible]
order to keep [illegible]
on test were conducted [illegible]
[illegible] as needed

Valve A was [illegible] ute of the microbalance [illegible] to bypass the [illegible] down tube and [illegible] through Valve B. Valve B was [illegible] the airflow through [illegible] These [illegible] prior to a [illegible] and Room [illegible] test system [illegible] the air [illegible] in the next section.

A secondary flow system was also shown in Figure [illegible] the [illegible] vacuum bottle dry during the droplet [illegible] dry nitrogen was flowed into the vacuum bottle at a very low [illegible]. This nitrogen flow mixed with the [illegible] air [illegible] hangdown tube attached to the vacuum bottle [illegible] air stream.

Of course, the air velocity in each test depended on the total [illegible] through the test system. The total flow [illegible] with the [illegible] approximately the air velocity for the test. The velocity was measured [illegible] anemometer. [illegible] anemometer [illegible] Inc., [illegible] meter, with [illegible] temperature sensor [illegible] small enough to be easily [illegible] hangdown tube.

Figure 5 shows the anemometer probe positioned below the DSD, the air velocity for the tests was actually measured at the drop location with the DSD removed.

7.2.5 Air-Humidification System

The air-humidification system consisted of an oil-less diaphragm vacuum pump (Model DOA-P104-AA; Gast Manufacturing Corporation, Benton Harbor, MI) to generate the required airflow, drying tubes to dry the air stream before entering the pump, a tee that split the dried air stream into what was called the "dry" air stream and the "wet" air stream, two needle valves to regulate the flow rates for the dry and wet air streams, two rotameters to measure the flow rates of the dry and wet air streams, a large three-neck flask filled with distilled water to humidify the wet air stream, a dispersion tube in the flask to bubble the wet air stream through the water, and another tee to mix the wet and dry air streams before flowing into the water bath. The relative humidity of the air stream as it blew onto and through the suspended droplets at the exit of the microbalance hangdown tube depended on the ratio of the flow rates of the dry and wet air streams in the humidification system and the temperature of the air stream at the drop location. The temperature of the air stream was controlled by the temperature-control system (see the next section).

The total flow rate through the test system was also measured and monitored by a digital linear mass flowmeter (Model FMA-5611; Omega Engineering, Inc., Stamford, CT) inline between the pump and the tee that split the air stream into the dry and wet air streams. This linear mass flowmeter had an analog output that was interfaced to the data-acquisition system (see Section 7.2.8). The total system flow rate was measured continuously during each droplet-evaporation test to indirectly monitor the air velocity in the test.

The large three-neck flask was placed in a heating mantle and was wrapped with insulation so that the flask could be heated to generate high humidities. The connections between the flask and the heat-traced Teflon line that led to the water bath were also wrapped with a heating ribbon to prevent a cold spot for condensation in the flow path.

The relative humidity (and temperature) of the air stream was measured using a an RH/temperature meter and probe (Model RH411 Thermo-Hygrometer; Omega Engineering, Inc., Stamford, CT). The probe was sealed in the three-neck flask in the flow system (see Figure 5). In droplet-evaporation tests that were conducted without airflow (see Section 8), the relative humidity (and temperature) inside the test chamber were measured with a second RH/temperature meter/probe (not shown in Figure 5) that was identical to the one fitted in the three-neck flask.

When we conducted our first tests at high temperature and high humidity, we experienced condensation problems in the system upon cooling after the tests. Therefore, we connected a nitrogen line to the input of the humidification system to dry out the system and to prevent condensation after each day of testing.

Figure 5 shows the [illegible] test probe and [illegible] ([illegible]), the air velocity for this test was actually measured [illegible] with the [illegible].

7.2. Air-Humidity Monitoring [illegible]

The air-humidity [illegible] system consisted of an oil-less diaphragm vacuum pump (model DOA-[illegible], [illegible] Benton Harbor, MI) to generate the [illegible] before entering the [illegible] that [illegible] was called the "dry" air stream [illegible] to regulate the flow rate [illegible] to measure the flow rates [illegible], a large three-neck flask filled with distilled water [illegible] [illegible] water [illegible] path. The relative humidity [illegible] [illegible] humidity [illegible] of the [illegible] [illegible]

[illegible] and [illegible] (see Section [illegible]) [illegible] continuously during each droplet-[illegible] air velocity [illegible]

The large three-neck flask was placed in [illegible] mantle and was wrapped with insulation so that the flask could be heated [illegible] humidities. The connections between the flask and the [illegible] Teflon line that led to the water bath were also wrapped with a heating ribbon to prevent a cold spot for condensation in the flow path.

The relative humidity (and temperature) of the [illegible] stream was measured using a [illegible] RH/temperature meter and probe [illegible] The [illegible] Omega Engineering, Inc., Stamford, CT). The probe was [illegible] in [illegible] flask in the flow system (see Figure [illegible]) [illegible] tests that were conducted without airflow (see Section 6), the [illegible] humidity (and temperature) inside the test chamber were measured with [illegible] temperature meter/probe (not shown in Figure 5) that was [illegible] in the [illegible] neck flask.

[illegible] we conducted our first tests at high temperatures and high [illegible] condensation problems in the system [illegible] [illegible] nitrogen line to the input of the [illegible] system and to prevent condensation after [illegible]

7.2.6 Temperature-Control System

The temperature of the air stream in the droplet-evaporation tests was controlled by using a water bath/circulator (Model 2095 Refrigerated and Heated Bath; Forma Scientific, Marietta, OH), a secondary water bath consisting of a stainless-steel tempering beaker filled with water, insulated lines for the airflow, and the specially designed vacuum-insulated glass hangdown tube attached to the vacuum bottle of the microbalance. The water bath/circulator was set to the temperature needed to produce the required temperature of the airflow exiting the hangdown tube and blowing onto the suspended droplets. Because of thermal losses or gains in the system, the water temperature usually needed to be set higher or lower than the specified test temperature.

The air stream from the humidification system passed through a copper coil inside the water bath to heat or cool the air stream as necessary. The air then flowed through insulated copper tubing into the three-neck flask where the temperature and relative humidity of the air stream were measured. The three-neck flask was mostly immersed in the secondary water bath (the tempering beaker filled with water). Temperature-controlled water from the water bath/circulator flowed through the walls of the tempering beaker so that its temperature and the temperature of the water inside it were very close to that of the water bath/circulator. From the three-neck flask, the air stream flowed through a Tygon-to-copper-to-Tygon line to Valve A. The copper line was insulated, and Valve A was made of Nalgene to minimize heat loss or gain. From Valve A, the airflow was directed through the hangdown tube or to Valve B.

In addition to the temperatures measured by the RH/temperature meters/probes (see the previous section), thermocouples measured the air temperature inside the microbalance vacuum bottle and the temperature of the air stream at the drop location (referred to as the drop temperature). The temperature inside the microbalance vacuum bottle was measured with a type-K thermocouple, and the temperature of the air stream exiting the glass hangdown tube was measured immediately below the position of the suspended droplets with a fast-response type-K thermocouple (Model SA1-K). Both of these thermocouples were connected directly to the data-acquisition hardware (see Section 7.2.8). The readings of these two thermocouples were checked against a calibrated type-K thermocouple and type-K handheld thermocouple thermometer (Model 873F). The thermocouples and the thermocouple thermometer were obtained from Omega Engineering, Inc., (Stamford, CT). The measured temperature of the air stream at the drop location and the measured temperature and relative humidity in the three-neck flask (or in the test chamber for tests without airflow) were used to calculate the relative humidity of the air stream at the drop location.

For the tests conducted at 40 °C, two light-socket cords with 300-W incandescent light bulbs were put inside the test chamber near the top to heat up the chamber as required. The two lights were wired to a dimmer switch to control the light intensity and, thus, the heating inside the test chamber.

To help cool the air stream for the tests conducted at 15 °C, thin-walled (for flexibility) PVC tubing was wrapped around the Tygon tubing from Valve A to the hangdown tube and around the hangdown tube. Cooled water from a second water bath/circulator (Endocal Refrigerated Circulating Bath, Model RTE-5B; NESLAB Instruments, Inc., Portsmouth, NH) was flowed through the PVC tubing to cool more efficiently the airflow. The PVC tubing from the water bath to Valve A to the end of the hangdown tube was covered with insulation for added effectiveness.

7.2.7 Photographic System

The photographic system consisted of a telemicroscope fitted with a 35mm camera to view and photograph the suspended droplets, an electronic flash unit (not shown in Figure 5) that was mounted to provide optimum photographic illumination of the droplets, fluorescent lighting (not shown in Figure 5) to illuminate the droplets when viewed through the camera/telemicroscope, a high-quality flat-surface mirror to view the suspended droplets from below, and an electrical switch (not shown in Figure 5) to send a signal to the data-acquisition system each time that a photograph was taken.

The telemicroscope was a Model 77 Micro Telescope from Davro Optical Systems (Lansdale, PA). The telemicroscope was mounted on X-Y-Z translational stages to position and rough focus the telemicroscope. The telemicroscope was fine focused using its own focus knob. The camera was a Nikon FE2 SLR camera with a Nikon MF-16 Data Back. The flash unit was a Vivitar Model-283 automatic electronic flash. The mirror was a 4-in.-diameter aluminum-surface mirror (Newport Corporation, Fountain Valley, CA) and was held in a Gimbal mirror mount that was attached using a 45° mounting bracket to the bottom of the test chamber. The telemicroscope and mirror were precisely adjusted to give the camera a planar view of the suspended droplets on the filaments of the DSD when the DSD was attached to the microbalance hangdown wire.

7.2.8 Data-Acquisition System

The main components of the data-acquisition system included a Swan XT10 microcomputer from Tussey Computer Products (State College, PA), a 16-bit analog-to-digital (A/D) interface board, a terminal block for connecting analog input lines to the A/D board, and data-acquisition software. The A/D board (Model ACPC-16), terminal block (Model ACPC-16-8-T11), and data-acquisition software were all obtained from Strawberry Tree Computers, Inc., (Sunnyvale, CA). The A/D interface accommodated eight analog channels. The following devices were interfaced to the eight channels:

- microbalance
- RH/temperature meter
- drop-temperature thermocouple

- microbalance thermocouple
- linear mass flowmeter
- photo switch
- spray switch

In the case of the RH/temperature meter, two different meters with probes were included in the droplet-evaporation test system (as described in Section 7.2.5) -- one located in the three-neck flask for measuring the RH and temperature of the air stream in the tests with airflow, and one located in the test chamber for measuring RH and temperature in the tests without airflow (see Section 8). The RH and temperature outputs from these two meters were wired into a box with a toggle switch that was used to select the readings from only one of the two meters to be sent to the computer interface board. That is, only one of the RH/temperature meters was interfaced to the computer at a time.

The photo switch and the spray switch were each merely a switch connected in series with a battery to provide a voltage signal to record the time at which a photograph was taken or the time at which droplet-spraying ended (the true start of droplet evaporation). The two switches were manually switched on (measurable positive or negative voltage) at the start of a test and were then turned off (zero voltage) and back on at the appropriate times to mark the corresponding events.

7.3. Operation

7.3.1 Overview

The operation of the various subsystems of the droplet-evaporation test system are described in the following sections. These operating instructions are given in general terms. The specific experimental procedures for the droplet-evaporation test are given in Section 8. The following discussion of the general operation of the test system refers to Figure 5.

7.3.2 Droplet-Spraying Apparatus

Before using the atomizer, the flow rate of the nitrogen stream to be used for the sprayer was checked by opening the two-way valve and by turning the three-way valve to direct the nitrogen stream to the two-way valve. The rotameter attached to the two-way valve was used to measure the nitrogen flow rate. The flow rate was adjusted with the regulating valve after presetting the pressure required for the particular test substance. After checking the flow rate, the two-way valve was closed.

The atomizer was filled with approximately 1 mL of the substance to be sprayed. To spray droplets onto the DSD filaments, the DSD was held with anti-magnetic tweezers, and it was rested on the back of the DSD holder over the hole in the holder. Using a clock inside the chamber to time the

spraying, the three-way valve was turned towards the sprayer for the predetermined time interval and then back towards the two-way valve to stop the spraying.

After the test, the suction device was utilized to clean out the atomizer by inserting the end of the 1/16-in.-O.D. tubing inside the atomizer. After the excess test substance was removed, the atomizer was rinsed with Milli-Q water, which was also suctioned out of the atomizer.

7.3.3 Electronic Microbalance

The microbalance was operated according to the manufacturer's instructions. Basically, the settings of the control unit of the microbalance were set, and tare weights were selected so that the microbalance could be zeroed with the dry DSD and so that the mass of the droplets sprayed onto the DSD filaments could be weighed directly. The microbalance was always allowed to warm up sufficiently before use.

7.3.4 Airflow System

The main airflow through the test system was produced by the pump in the air-humidification system. The flow path and flow rate of the air stream were controlled with the various valves, and the flow rate was measured with the various flowmeters described above in Sections 7.2.4 and 7.2.5. The air velocity was measured with the anemometer described above in Section 7.2.4. As previously mentioned, Figure 5 shows the anemometer probe positioned below the DSD, but the air velocity for the tests was actually measured at the drop location with the DSD removed. See Section 8 for specific information about how the system flow rate and the air velocity were set and controlled in the droplet-evaporation tests.

7.3.5 Air-Humidification System

Specific instructions about using the air-humidification system in the droplet-evaporation tests are given in Section 8.

7.3.6 Temperature-Control System

The temperature of the air stream in a droplet-evaporation test was primarily controlled by the temperature of the main water bath/circulator and was affected by the flow rate of the air stream through the system. The temperature of the water bath was set using the temperature control on the water bath and was monitored using the bath thermometer. The circulator for the water bath was turned on to control the temperature of the secondary water bath (the tempering beaker that contained the three-neck flask shown in Figure 5). The water levels in both of these water baths were maintained at the appropriate levels. See Section 8 for specific instructions about the setting of the temperatures for the droplet-evaporation tests.

Additional temperature control (and humidity control in some cases) was afforded by the heating mantle for the water flask in the humidification system, the heating ribbon on the output connectors of the

[illegible] The three-way valve was turned [illegible] flask for the time interval and then back [illegible] valve to stop the [illegible].

After the test [illegible] atomizer by [illegible] 1/16-in O.D. [illegible] the excess [illegible] Milli-Q water [illegible]

7.3.5 F[illegible]

[illegible] instructions. Basically, the [illegible] ISD [illegible] to warm up sufficie[illegible].

In the air-sum diffiser system [illegible] the various flowmeter [illegible] and [illegible] The air velocity was measured [illegible] 7.3.6. As previously ment[illegible] positioned below the [illegible] but the [illegible] measured at the [illegible] DSD removed. [illegible] specific information about [illegible] rate [illegible] velocity were set and controlled in the [illegible] tests.

[illegible] Air Humidificat[illegible]

[illegible] instructions [illegible] the air-humidification system in [illegible] operation tests [illegible] given in Section 8.

7.3.[illegible] Temperature Control Syst[illegible]

The temperature of the air stream in a droplet evaporation test [illegible] controlled by the temperature of the main water bath [illegible] affected by the flow rate of the air stream through the system. [illegible] of the water bath [illegible] using the temperature control in the [illegible] bath [illegible] the bath thermometer. The [illegible] was turned on to control the temperature of the secondary water [illegible] bubbler [illegible] the three-neck flask [illegible] water levels in each of these water baths were maintained [illegible] Section 8 for specific instructions about the [illegible] droplet evaporation tests.

[illegible] and humidity control in [illegible] the water flask in the [illegible] setting [illegible] the output connector of the

humidification system, and the heat-traced line from the humidification system to the main water bath. The heating mantle, the heating ribbon, and the heat-traced line were separately controlled with variable-voltage controllers. The second water bath/circulator that circulated water through the PVC tubing that was wrapped around the hangdown tube was also important for low temperature tests, and the dimmer-controlled 300-W lights in the test chamber were important for the high-temperature tests. These devices were adjusted as necessary to achieve the required temperatures for the tests.

7.3.7 Photographic System

Operation of the photographic system consisted of turning on the external lighting and operating the camera. Operation of the camera and the flash unit was straightforward. Section 8 describes the taking of photographs in the droplet-evaporation tests.

7.3.8 Data-Acquisition System

Operation of the data-acquisition system was almost completely automatic. When the computer was turned on and all instruments or equipment interfaced to the computer were turned on, the data-acquisition system was running. The data-acquisition software logged the acquired data into an ASCII computer file that was compatible with importing into a spreadsheet program for data reduction. We used Lotus 1-2-3 (Lotus Development Corporation, Cambridge, MA) for data reduction (see Section 8.8), but other spreadsheet programs could have been used. The only steps the operator had to take with regard to the data-acquisition system were to verify that all channels were reading properly and to set up the data file (i.e., name the data file) for each test. The specific use of the data-acquisition system is described in the test procedures for the droplet-evaporation tests (see Section 8).

7.4 Calibration

7.4.1 Overview

Numerous measurements were made during each droplet-evaporation test (see Section 8). The requirements for the precision and accuracy of each measurement depended on the particular measurement being made. Some of the measurements were made merely to monitor for changes in the test system that would indicate potential problems, and therefore, such measurements did not have to be made with high precision and accuracy. Other values had to be measured accurately with known precision. The most important parameters measured with the droplet-evaporation test system included the mass of the droplets (as a function of time), the air velocity, the temperature and relative humidity of the air stream, and the number of droplets in each test.

The droplet-evaporation test system included several different measuring devices that included the microbalance, two temperature/humidity meters with probes, two thermocouples, five rotameters, the linear mass flowmeter, the anemometer, and the photographic equipment. All of the measuring devices except the rotameters, the anemometer, and the photographic equipment were interfaced to the data-acquisition system (A/D interface and

microcomputer) that stored data electronically. In most cases, the function of each measuring device was completely separate from the data-acquisition system; for example, the temperature/humidity meters, the linear mass flowmeter, and the microbalance all output voltages to the computer interface that were proportional to their internal readings. The data-acquisition hardware read the voltages, and the data-acquisition software running on the microcomputer converted the voltages to readings with the correct units. In the case of the two thermocouples, the data-acquisition system was an integral part of these measuring devices. That is, the thermocouples worked with the A/D interface to produce temperature readings.

It is important to understand how the measuring devices worked with the data-acquisition system when determining measurement errors and for defining calibration procedures. The microbalance was calibrated using the readings displayed by the computer. The thermocouple readings displayed by the computer were checked against a calibrated thermocouple and meter. During a test, readings displayed by the computer were also saved in a data file. The reliability of the stored data was ensured by checking the data against values that were recorded manually during the test.

The following sections discuss the calibration of various components of the test system, particularly the measuring devices, and the errors associated with the various measurements that were made.

7.4.2 Droplet-Spraying Apparatus

The droplet-spraying apparatus could not be calibrated to determine drop size versus spray time for the suspended droplets because it was not possible to control precisely the operation of the spray apparatus. The behavior of the atomizer inherently varied from test to test, the different test substances sprayed differently, and the spray times were manually controlled. Calibration of the sprayer was not really necessary, however, because we determined the average drop size that was actually produced in each test. Regardless of the fact that we did not need to calibrate the sprayer, we still determined approximate spray times in preliminary tests with water so that we could generate drop sizes close to the target drop sizes. The actual drop sizes that were generated in the tests are described and discussed in Sections 9 and 10.

7.4.3 Electronic Microbalance

The calibration of the microbalance with a 100-mg Class 1.1 ASTM standard weight (tolerance within ±5 μg) is described in the microbalance manual. Calibration with this weight was performed at the beginning of the test study and after each time that the temperature inside the test chamber was changed to or from the target temperature of 40 °C. The microbalance calibration was also checked on each day of testing with a daily calibration weight.

The sensitivity of the microbalance that we used ranged from about 1 to 5 μg. During use, however, the noise level of the microbalance was significantly greater than the ultimate sensitivity because of a slight motion

[illegible] level [illegible] graphically. [illegible] cases, the [illegible] with [illegible] during [illegible] systems; for example, [illegible] temperature [illegible] linear [illegible] and the [illegible] voltage [illegible] were proportional to their [illegible] these [illegible] the voltages [illegible] microcomputer converted the volt[illegible] the case of the two [illegible] of these measuring [illegible] interface to produce [illegible]

With the data [illegible] [illegible] display [illegible] computer [illegible] a test [illegible] initial [illegible] of the [illegible] values that were [illegible] manually [illegible]

The following sections [illegible] components of the [illegible] system [illegible] associated [illegible]

4.2 Droplet-Spray [illegible]

The droplet spray [illegible] determine drop size versus [illegible] was not possible to control [illegible] The behavior of the [illegible] different test substances [illegible] manually [illegible] because we determined [illegible] used in each test [illegible] the spray [illegible] tests with water [illegible] drop sizes. The actual drop [illegible] generated [illegible] and discussed in Sections [illegible]

calibration of the microbalance [illegible] = [illegible] is done [illegible] the [illegible] with [illegible] weight was performed at the beginning of [illegible] that the temperature inside [illegible] temperature [illegible] C. The micro-balance [illegible] on each day of testing with a daily calibration [illegible]

[illegible] microbalance, [illegible] ranged from above [illegible] the noise level of the microbalance was [illegible] sensitivity because of a slight [illegible]

of the DSD and by the flow of water (in the tests at 15 °C) through the PVC tubing that was wrapped around the hangdown tube. When the airflow was directed at the droplets, the noise level increased significantly, but no important mass measurements were made with the airflow directed at the droplets. The relative error in the mass measurements (without airflow directed at the droplets) depended on the noise level and on the magnitude of the mass of the droplets being measured. That is, the relative error was more significant for the smaller droplets. The data for each test must be analyzed individually to determine the noise level and error associated with the mass measurements for that test.

7.4.4 Airflow System

Measured flow rates in the test system were only useful in setting flow rates that determined the air velocity, temperature, and relative humidity for a droplet-evaporation test. The actual values of the flow rates were not important quantitative data, but changes in the flow rates during a test could be important if such changes caused a change in the air velocity, temperature, or relative humidity. For these reasons, the measured flow rates were recorded immediately before and after a test to show that no significant changes occurred. Also, the total flow rate through the test system was monitored throughout a test by the linear mass flowmeter just downstream of the pump. Before each test, this flow rate was monitored for a sufficient time to determine a baseline flow rate and the random variation in that flow rate. Because the actual flow rates were not important, calibration of the flowmeters was not required.

The air velocity, however, was an important experimental parameter that was measured with an anemometer. The Kurz anemometer that we used was calibrated by the manufacturer, and the certified calibration was NBS traceable. For air velocities measured on the 0- to 50-ft/min analog scale of the anemometer, the estimated reading error was ±5 ft/min; for the 100- to 200-ft/min scale, the estimated error was ±10 ft/min; and for the 100- to 500-ft/min scale, the estimated error was ±25 ft/min. When making the air-velocity measurements, we selected the most precise scale that could be used.

7.4.5 Air-Humidification System

The measured flow rates of the rotameters in the humidification system were only important for measuring the relative wet and dry airflows for the humidification system. The actual values of these flow rates were not important experimental data. Only the temperature and relative humidity and the air velocity of the air stream had to be measured reliably. Knowledge of the flow rates were only useful for quickly generating the required conditions for the air stream before a test.

The RH/temperature meters and probes used in the test system were designated as Meter 1, Probe 1, Meter 2, and Probe 2. These RH/temperature meters were calibrated by the manufacturer, and the calibration was expected to be valid for three years. It is important to note that each meter/probe pair was calibrated as one measuring unit. To verify that the meters were still measuring RH and temperature accurately for the droplet-evaporation

of the [illegible] and by the flow [illegible] meter [illegible] that [illegible] the [illegible]
[illegible] was stopped [illegible] When [illegible] was [illegible] of the [illegible], the [illegible] level [illegible] measurements [illegible] made with [illegible] The relative error [illegible] at [illegible] of the [illegible] significant for [illegible] gradually [illegible] measurements for [illegible]

7.4.4 [illegible] System

[illegible]

The [illegible] however [illegible] The [illegible] velocity [illegible] the [illegible] reading [illegible] scale, the [illegible] error was [illegible] scale, the [illegible] velocity measurements, we selected the most precise scale [illegible]

7.4.5 [illegible] humidification system

The measured flow rates of the rotameter in the humidification [illegible] were only important for measuring the relative [illegible] system. The actual values of these flow rates were not [illegible] data. Only the [illegible] and relative humidity and velocity of the air stream [illegible] were [illegible] useful for [illegible] the required [illegible] air stream before a test.

[illegible] and [illegible] in the test [illegible] were [illegible] 1, [illegible] 2 and [illegible] 2. These [illegible] manufacturer, and the calibration was expected [illegible] It is important [illegible] verify that the meters were [illegible] accurately for the [illegible]

study, the meter/probe pairs were checked prior to the droplet-evaporation study and after Meter 1/Probe 1 had to be replaced when it failed during testing. The meter/probe pairs were checked against one another and directly or indirectly against a wet-bulb/dry-bulb hygrometer and a calibrated thermocouple and meter. Because Probe 1 was sealed in the three-neck flask and could not be easily removed, the reading of Meter 1/Probe 1 was checked against Meter 2/Probe 2, which was checked against another standard.

To check Meter 1/Probe 1 versus Meter 2/Probe 2, both were used to measure the same air stream at a known temperature and relative humidity. This was accomplished by temporarily routing the airflow out of the three-neck flask into a second three-neck flask that was also mostly submerged in a water bath (tempering beaker filled with water) similar to the one in which the first three-neck flask was contained. The water from the circulating water bath was temporarily plumbed to flow through both tempering beakers so that the temperatures of both three-neck flasks were the same. Meter 2/Probe 2 was temporarily sealed in the second three-neck flask. The humidified air stream through both three-neck flasks was allowed to equilibrate (as shown by steady readings of both meters).

The readings of both meter/probe sets were checked at three humidities (low, moderate, and high) at the test temperature to verify that the meters gave the same readings within the manufacturer's accuracy specifications (±5% for RH and ±1 °F for temperature) for the meter/probe combinations. Meter 2/Probe 2 was also checked against a wet-bulb/dry-bulb hygrometer under the same temperature and RH conditions and was also checked against a calibrated thermocouple and meter. If the readings of the meter/probe pairs did not agree, a determination was made about which meter/probe was out of calibration. As necessary, Meter 2/Probe 2 was re-calibrated for RH against Meter 1/Probe 1 if Meter 1/Probe 1 was known to be accurate, or Meter 2/Probe 2 was re-calibrated using standard salt solutions as described in the manual for the RH/temperature meter and probe. Meter 1/Probe 1 was re-calibrated as necessary against Meter 2/Probe 2.

7.4.6 Temperature-Control System

As previously described, particular air temperatures were measured during the tests with the RH/temperature meter/probe pairs (see the previous section). In addition, thermocouples measured the air temperature inside the microbalance vacuum bottle and the drop temperature (temperature of the air stream at the drop location). The vacuum-bottle temperature was recorded during the tests to monitor for potential problems. Baseline readings were recorded by the computer immediately before droplet-evaporation data were recorded. The thermocouple that measured the drop temperature was checked against a calibrated thermocouple and meter, which were calibrated as a unit against a mercury-in-glass thermometer (Fisher Scientific, Pittsburgh, PA) that had an NIST-traceable calibration. The accuracy of the temperatures measured with the various thermocouples was estimated to be ±2 °F.

7.4.7 Photographic System

The photographs taken during the droplet-evaporation tests contained images of the DSD filaments and the suspended droplets when present. The photographic system did not require any calibration because the average drop size in each test was calculated from the total initial mass of the droplets, the number of droplets as counted in the corresponding photograph, and the average filament diameter that was measured separately (see Section 8.7). There was some error associated with the counting of the droplets in the photographs because sometimes a few very small droplets were formed that were difficult to count. We estimate that the error in counting the droplets in the photographs was no more than ±3%, which amounted to a counting error of one or two droplets per photograph.

7.4.8 Data-Acquisition System

No specific calibration was required for the data-acquisition system. The readings displayed by the computer were either verified during the calibration of the corresponding measuring devices or were checked against calibrated measuring devices. To verify that the data-acquisition system was functioning properly during each droplet-evaporation test, computer-display readings for the various devices interfaced to the data-acquisition system were checked against the readings displayed by the individual devices that had their own displays or against measurements made with other devices.

8. DROPLET-EVAPORATION TEST PROCEDURES

8.1 General

The second and most important phase of Task TA-31 was the droplet-evaporation testing of the SDTF range-finding solutions. The droplet-evaporation tests were conducted as outlined in the Outline Plan for Task TA-31 and in the Study Protocol for SDTF Study P91-001.

8.2 Good Laboratory Practice (GLP) Procedures

The droplet-evaporation test data for the three SDTF range-finding solutions were generated according to EPA FIFRA Good Laboratory Practice (GLP) standards as defined in 40 CFR Part 160, effective October 16, 1989. The SDTF Study Protocol P91-001, SRI SOPs, and when necessary, SDTF SOPs were followed.

8.3 Test Substances

The SDTF range-finding solutions for the droplet-evaporation tests were described in Section 4.2.

8.4 Daily Preparation for Droplet-Evaporation Tests

8.4.1 Overview

Generally, several droplet-evaporation tests were conducted on a given work day. Preparation for the droplet-evaporation tests was performed

the photographs taken during the droplet-evaporation tests. [illegible] of the DST [illegible] and the sequence [illegible] when [illegible] system did not require any calibration because the average [illegible] each test was calculated from the total initial mass of the [illegible] of droplets [illegible] in the corresponding photograph, [illegible] a filament diameter that was measured separately (see [illegible]
7) There [illegible] error associated with the [illegible] of the [illegible] the photographs because sometimes a few very small droplets were [illegible] were difficult to [illegible]. We estimate that the error in counting [illegible] lets in the photographs was no more than 13% which amounted to [illegible] error of one or two droplets per photograph.

Data Acquisition System

No specific calibration was required for the data-acquisition system. The readings displayed by the computer were either verified by calibration of the corresponding measuring devices or [illegible] measuring devices. To verify that the data-acquisition system operated properly during each evaporation test, computer-display [illegible] for the various devices interfaced to the data-acquisition system [illegible] the readings displayed by the individual devices that had their own displays or against measurements made with other devices.

DROPLET-EVAPORATION TEST PROCEDURES

General

The second and most important phase of [illegible] TA-31 was the droplet-evaporation testing of the [illegible] range-finding solutions. The droplet-evaporation tests were conducted as outlined in the Outline Plan for Task [illegible] and in the Study Protocol for SOW Study PQ1-001.

Good Laboratory Practice (GLP) Procedures

The droplet-evaporation test data for the three SOW range-finding solutions were generated according to EPA FIFRA Good Laboratory Practice (GLP) standards as set forth in 40 CFR Part 160, effective October 16, 1989. [illegible] Protocol PQ1-001, SRI SOPs and, when necessary, SOW SOPs were followed.

Detailed Tests

[illegible] evaporation tests were conducted in a [illegible]
For the droplet-evaporation [illegible] was performed

at the beginning of each day that tests were conducted. The daily preparation typically did not need to be repeated on a given day. One of two types of tests were conducted during Task TA-31. Most of the tests were standard tests conducted with airflow, but we also conducted ambient tests without airflow. (In our SOPs, an ambient test was also referred to as a Case-1 test, and a standard test was also referred to as a Case-2 test.) These two types of tests are described in more detail in Section 8.5.9 but are referred to before that section.

8.4.2 Daily Checklist

A daily checklist (Daily Checklist for Droplet-Evaporation Tests) was used on each day of testing to ensure that the daily preparation for the droplet-evaporation tests was performed properly. The checklist was also used at the end of the day to shut down the system (see Section 8.6).

8.4.3 Preparation and Handling of Test Substances

The test substance for each day of testing was prepared and handled according to applicable SRI SOPs and according to the Study Protocol for SDTF Study P91-001. Specific information about the preparation and usage of the test substances was recorded in appropriate logbooks.

All of the tests reported in this report were conducted using a small atomizer as previously described. Approximately 50 mL of the test substance was transferred to a small narrow-mouth polyethylene wash bottle that was used to fill the atomizer when needed.

8.4.4 Preparation of Test System

The droplet-evaporation test system was described in Section 7, and a schematic diagram of the droplet-evaporation test system was shown in Figure 5. This section of the data report describes the detailed preparation of the test system for conducting droplet-evaporation tests.

8.4.4.1 Droplet-Evaporation Test-System Logbook

The date, user name, project number, and any pertinent comments were recorded in the test-system logbook each day that the droplet-evaporation test system was used to perform tests.

8.4.4.2 Microbalance

The microbalance was checked to be sure that all electrical connections were made and that the power was still on from the previous day. The microbalance was allowed to warm up at least overnight prior to use for the droplet-evaporation tests. For the most part, the microbalance was left on during the course of the experimental study. The output switch for the microbalance was switched to the SHORT position when measurements were not being made.

The hangdown wire for both the sample side and the tare side were checked to be sure that everything was ready. The tare weight was also checked.

A clean droplet-suspension device was selected for use, and the DSD number was recorded on the daily checklist. The DSD was cleaned prior to testing by dipping it into distilled water and swirling it gently. The DSD was dried completely before use. The DSD was then suspended from the microbalance hangdown wire.

8.4.4.3 Flow System

The flow system (including flow components of the humidification system) was checked for proper connection for the day's tests. The flow of compressed nitrogen through the microbalance vacuum bottle was checked to ensure that it was at a flow rate of 50 mL/min as read by Rotameter 3. With the main system flow off, Valve A was turned to direct the main flow of the test system through Valve B. Valve B was turned to direct the flow through Rotameter 1 (high flow rate) or Rotameter 2 (low flow rate) depending on the flow rate needed for the first standard test of the day.

8.4.4.4 Humidification/Temperature-Control System

The main water bath/circulator was set to the required temperature for the tests to be conducted that day, and then the bath/circulator was turned on so that it could pre-equilibrate. The circulation of water through the tempering beaker that contained temperature/humidity Probe 1 was checked. The drying tubes before the pump were checked, and the drying agent was replaced as needed. The pump for the humidification system was then turned on, and the relief valves on the pump and the wet and dry rotameters were adjusted to produce the approximate flow rate and relative humidity for the first standard test of the day. Temperature/humidity Meter 1 was turned on to monitor the temperature and humidity of the flowing air stream, and temperature/humidity Meter 2 was turned on to monitor the temperature and humidity inside the test chamber. Note that to save time, the water bath/circulator and the temperature/RH meters were typically left on during the test program.

For high-temperature (40 °C) and/or high-humidity tests, the variable-voltage controller that powered the heat-traced line from the humidification system to the main water bath was turned on and adjusted. Also for high-temperature tests, the variable-voltage controllers that powered the heating mantle under the humidification-system water flask and the heating ribbon in the humidification system were turned on and adjusted. The lights inside the test chamber were also turned on, and their brightness was adjusted with the dimmer switch.

For tests conducted at low temperature (15 °C), the second water bath/circulator was turned on to circulate cooled water through the PVC tubing that was wrapped around the microbalance hangdown tube. This water bath was usually left on for the duration of a series of low-temperature tests.

After all components of the humidification/temperature-control system were turned on and adjusted, the air stream was allowed to equilibrate in temperature and relative humidity. Fine adjustments were made to the various controls as necessary.

8.4.4.5 Photographic System

The flat-surface mirror was checked to be sure that it was clean. If necessary, the mirror surface was gently cleaned with lens paper and acetone. As needed, a new roll of film was opened, the first date of use was recorded directly on the film canister with a pen or marker, and the film was loaded into the camera. All of the camera settings were checked to be sure they were properly set. The necessary information about the film was recorded, and the camera settings were recorded. The film was checked to ensure that it advanced properly. The batteries in the camera and the electronic flash (unless it was powered by a voltage adapter) were checked. The databack on the camera was set to imprint the date on the photographs. The fluorescent lighting that illuminated the filaments of the DSD was turned on.

The DSD was viewed through the camera viewfinder, and the telemicroscope was aligned and focused on the bare filaments of the DSD. One or two photographs of the bare filaments were manually taken to document the date on the roll of film. If any photographic problems were evident (for example, the flash did not work), the problem was corrected and additional photographs were taken until at least one good photograph could be expected. The necessary information about the photographs was recorded. The camera databack was reset to imprint the photograph number on subsequent photographs. The number to be imprinted on the next photograph was checked and corrected if necessary. The dated photographs were included in the photograph count.

8.4.4.6 Data-Acquisition System

The data-acquisition microcomputer was turned on. After the computer booted up and the data-acquisition software started up, the readings on the computer display were checked to verify that computer measurements were being made. The temperature and relative-humidity readings on the computer were checked against the display readings on the two RH/temperature meters. Selection between the two meters was made using the toggle switch. The readings of the microbalance thermocouple and the drop-temperature thermocouple were checked to be sure that they were reading properly. The voltage reading (approximately 1.5 V) for the photo switch and the voltage reading (approximately -1.5 V) for the spray switch were checked to be sure that the switches worked properly. Verification was made that each switch changed the voltage to zero when it was turned off. The reading for the linear mass flowmeter was checked to ensure that it was functioning properly.

The microbalance output was switched to OUTPUT to ensure that the microbalance was working. The microbalance reading was zeroed with the DSD suspended. After the microbalance was zeroed, the microbalance was switched to SHORT, and the daily calibration weight (10 mg) was carefully suspended along with the DSD from the suspension wire. The microbalance was switched to

After all components of the humidity [illegible] apparatus were turned on and adjusted, the air stream was allowed to stabilize [illegible] temperature and relative humidity [illegible] were made [illegible] various controls as necessary.

8.4.4.5 Photographic System

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8.4.4.6 Data-Acquisition System

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[illegible] suspension wire. The microbalance was switched to

OUTPUT, and the mass of the calibration weight was measured and recorded; if the measured mass was 10.3 ± 0.1 mg, the microbalance was functioning properly. The microbalance switch was returned to SHORT. The daily calibration weight was removed and stored.

8.4.4.7 Drop-Spraying Apparatus

The drop-spraying apparatus was checked to be sure that it was ready for testing. The supply of compressed nitrogen for the drop-spraying apparatus was checked for a sufficient amount for the day's tests. The atomizer was cleaned and readied for use. The nitrogen flow rate for the atomizer was set to the required flow rate as read by the rotameter for the spraying apparatus.

8.5 Specific Test Procedure

8.5.1 Test Checklist

A test checklist (Checklist for Individual Droplet-Evaporation Tests) was used to ensure that the test procedure was followed correctly and to record pertinent information.

8.5.2 Test Number

It is important to note that each test had a unique test number that was assigned to it based on the date of the test and a letter from the alphabet corresponding to the order that tests were conducted on that particular date. For example, the third test conducted on September 1, 1992, had the test number 090192C. Test numbers were assigned in this way so that they could be easily identified and so that the first seven digits of the filenames for the corresponding computer data files could be the same as the test numbers. That is, the ASCII computer file containing the raw data for Test 090192C has the same name (see Section 8.5.6), and the reduced computer data file for this test has the same name with a ".WK3" extension added that indicates that the reduced data file is a Lotus 1-2-3, Release 3.x spreadsheet file (see Section 8.8).

Every test number was assigned immediately prior to the test and was not changed. If the test had to be aborted for one reason or another, the test number remained associated with the aborted test to prevent confusion.

8.5.3 Flow Equilibration

If an ambient test (no airflow) was to be conducted, the following steps described in this section were skipped.

The DSD was temporarily removed, and the anemometer probe was positioned at the drop location. The thermocouple that measured the drop temperature (i.e., the temperature at the location where droplets would be exposed) was left in its proper location. Valve A was turned to direct the air stream through the hangdown tube. The following values were then read: the measured temperature and RH of the air stream in the three-neck flask, the

measured velocity of the airflow at the drop location, and the drop temperature. The anemometer was momentarily turned off and moved away from the drop location while measuring the drop temperature. Using the measured temperature and RH of the air stream, the measured drop temperature, and tables of RH conversion factors, the RH at the drop location was calculated. The total flow rate through the test system, the relative flow rates of the wet and dry air streams, and the temperature of the water bath/circulator were adjusted to produce an air stream at the required temperature, relative humidity, and air velocity at the drop location. When the required conditions were attained, the readings were recorded. The calibrated thermocouple and meter were used to verify the drop temperature.

Valve A was turned back to direct the air stream through Rotameter 1 or 2, and then the total system flow rate as measured by Rotameter 1 or 2 was recorded. This flow rate and the RH and temperature in the three-neck flask were monitored (when possible) during the test(s) to be sure that conditions did not change significantly. If changes were apparent, the system was reset to the correct conditions. After setting the environmental conditions, the anemometer was turned off, and the anemometer probe was moved away from the drop location.

The laboratory temperature and the temperature inside the test chamber as read by RH/temperature Meter 2 were recorded. The switch that selected between the two RH/temperature meters was then switched to the correct meter for the test.

The DSD number was rechecked and recorded, and the DSD was re-suspended.

8.5.4 Droplet-Suspension Device and Preliminary Photograph

All of the camera settings were checked to be sure they were correct for the test. The camera settings were recorded. The camera databack was checked to be sure that the photographs would be imprinted with the correct photograph number. With only the 50-mL/min dry nitrogen flow through the microbalance vacuum bottle and hangdown tube, the camera/telemicroscope was focused on the bare filaments of the DSD. A photograph of the bare DSD filaments was manually taken to document the appearance of the bare DSD. If there was any apparent problem with the photograph, a second photograph was taken. The camera was checked to be sure that the film advanced and that the camera was ready to take additional photographs. Information about the photograph(s) was recorded on the test checklist.

8.5.5 Microbalance

Verification was made that the main flow through the test system bypassed the hangdown tube and that the flow rate of dry nitrogen through the microbalance vacuum bottle and hangdown tube was 50 mL/min. With only the clean, dry DSD suspended from the microbalance, the microbalance was zeroed. The microbalance output was returned to SHORT.

8.5.6 Data-Acquisition

A final check was made of the values displayed by the computer (except for the reading from the microbalance, which was switched to SHORT). The toggle switch for the two RH/temperature meters was double checked at this point to be sure that it was switched to the correct position for the test.

If the test was an ambient test (no airflow), the steps in the next paragraph were skipped.

Valve A was turned to redirect the flow of air through the microbalance hangdown tube. The microbalance was switched to OUTPUT to measure the drag weight of the bare DSD. When the mass reading on the computer was relatively stable, the approximate drag weight was recorded. The microbalance was returned to SHORT. Valve A was left in position to direct the airflow through the hangdown tube to re-equilibrate the air stream as it flowed through the hangdown tube.

The computer software was switched from the Display Mode to the Setup Mode. The filename for data logging was then changed to the test number using the following format:

MONTH + DAY + YEAR + TEST LETTER

For example, the second test conducted on October 12, 1992, had the following filename and test number:

101292B

Using this format, up to 26 filenames (and 26 test numbers) could be created in one day.

The data-acquisition program was then returned to the Display Mode (with data logging). The display readings were then checked for reliable readings for all channels. The measured mass showed that the microbalance was still shorted. The program was then switched to the Graphing Mode for visual monitoring of the data logging. When all channels showed equilibration for approximately five minutes, the main airflow was diverted away from the hangdown tube by turning Valve A. (Valve A was already turned to bypass for an ambient test.) The microbalance was then switched to OUTPUT to collect baseline data for the microbalance to establish the baseline and the noise level without airflow. Baseline data were collected for at least five minutes. Then, for a standard test, Valve A was turned to direct airflow through the hangdown tube to collect data on the DSD drag weight and collect drag data for five minutes. The microbalance output was switched to SHORT and the software was returned to Display Mode. The computer was allowed to continue collecting data while proceeding to the next step of the test procedure.

8.5.7 Droplet Spraying

The spray time to be used for the test was recorded. The atomizer was checked to make sure that the atomizer nitrogen flow was diverted away

from the atomizer. The contents of the wash bottle containing the test substance were agitated, and the atomizer was filled. If necessary, the small atomizer was rinsed once or twice with some of the test solution. The atomizer was positioned and momentarily turned on to check its operation and to flush it out with fresh solution.

Valve A was turned to bypass the hangdown tube. The DSD was carefully grasped with a pair of tweezers and was centered over the hole in the plastic shield through which the atomizer sprayed its mist. The spray switch was turned off and, while watching the second hand on a clock, the three-way valve that controlled the flow of nitrogen to the atomizer was turned on. The DSD filaments were sprayed for the required spray time. At the end of the required spray time, the sprayer was quickly turned off, and the spray switch was turned back on to record the end of the spray time. (It is important to note that the spray switch was not used to document the actual spray time but the moment that spraying was stopped. The actual spray time was recorded in the test checklist.) The DSD was then quickly and carefully re-suspended from the hangdown wire of the microbalance.

8.5.8 Measurement of Initial Drop Size

As soon as possible after the DSD and droplets were suspended from the hangdown wire, the door on the test chamber was closed and the microbalance was switched to OUTPUT. The telemicroscope was quickly focused on the droplets and an initial photograph of the droplets was taken. The photo switch next to the camera was switched at the same time that the photograph was taken, and the photograph number was recorded. The approximate initial total mass of the droplets was read and also recorded on the test checklist.

8.5.9 Measurement of Evaporation Rate

The next step in the test procedure was to measure the evaporation of the droplets. The ambient and standard test cases are described in the following subsections.

8.5.9.1 Ambient (Case-1) Test

This was a control test to measure droplet evaporation in the absence of airflow. In this case, the microbalance was allowed to continue to acquire data with no exposure of the droplets to airflow. For an ambient test, the temperature and relative humidity for the test were the ambient conditions in the test chamber. These conditions were measured using temperature/humidity Meter 2/Probe 2. Photographs were taken manually during the test. The last photograph was usually taken at the moment when the droplets appeared to evaporate completely. When a photograph was taken, the photo switch was manually activated, and the photograph number was recorded.

Because the temperature and relative humidity could not be controlled in ambient tests, the usefulness of the data are limited. However, the data can be used to generate curves of evaporation rate versus drop size in the absence of airflow. The data can also be used to estimate (by

extrapolating backwards) the amount of evaporation that may have occurred between the time that droplets were sprayed on the DSD and the time that the initial mass of the droplets was measured in the test. This estimation would apply to any ambient or standard test that was conducted with similar ambient conditions in the test chamber.

8.5.9.2 Standard (Case-2) Test

This test case was used to measure the overall evaporation rate for droplets exposed to a constant air velocity. As soon as the initial total mass of the droplets was measured and recorded and the initial photograph of the droplets was taken, Valve A was turned to direct the airflow through the hangdown tube. When the droplets had almost completely evaporated, the airflow was quickly turned to bypass so that the residual mass of the droplets could be measured. It was important that the droplets still have enough mass to be reliably measured. As soon as Valve A was turned to bypass, the camera/telemicroscope was quickly refocused on the droplets and a final photograph of the droplets was taken. The photo switch was activated at the moment that the final photograph was taken, and the photograph number was recorded.

The value of the data from the standard droplet-evaporation tests is discussed in Section 10.

8.5.10 Completion of Test

When the droplets in the evaporation test completely evaporated, the microbalance was switched to SHORT. The computer software was returned to Setup Mode to stop data collection. The data file was set to DUMMY to protect the test file. The flow rates for the wet and dry air streams were checked, and the total system flow rate as measured by Rotameter 1 or Rotameter 2 was checked and recorded. The DSD was removed and dipped in distilled water to clean it, and then it was dried for another test. The atomizer was cleaned and rinsed with distilled water in preparation for another test.

8.6 Daily Shutdown

After the testing for the day was completed, the DSD and atomizer were thoroughly cleaned. The microbalance was left on with the output switch in the SHORT position. The system airflow was turned off, the valve for the wet airflow was closed, and the nitrogen flow for the atomizer was turned off. The dry nitrogen flow through the test system was started to dry out the system. All variable-voltage controllers were turned off or turned down as needed. When used, the lights in the test chamber were turned down but were left on to maintain an elevated temperature in the test chamber. The photo switch and the spray switch were turned off, and the computer was turned off. The photographic equipment was turned off and the telemicroscope was capped. The water bath/circulator(s) was left on. All of these shutdown procedures were checked off at the end of the daily checklist (Daily Checklist for Droplet-Evaporation Tests) that had also been used at the beginning of the day.

8.7 Measurement of DSD Filament Diameters

The diameter of each glass filament on each DSD that was used for testing was measured using a Zeiss Polarizing Microscope (Carl Zeiss, Inc., Thornwood, NY). The microscope was calibrated before it was used. The diameter of each filament was measured in μm, and then the average filament diameter was calculated for each DSD. The error on the individual filament measurements was estimated to be 2 μm.

8.8 Data Reduction, Analysis, and Handling

The raw experimental data from each droplet-evaporation test primarily consisted of the following five components: (1) the daily checklist for the test system, (2) the checklist (and data form) for the individual test, (3) the data file generated by the data-acquisition computer during the test, (4) the corresponding photographs in the developed proof sheet of the film used during the test, and (5) the average measured filament diameter for the DSD used in the test. All of these items were previously described.

The daily and test checklists were stored in binders that were kept in a limited-access laboratory or office that was locked at night. The data files that were generated on each day of testing were stored on the hard drive of the data-acquisition computer until the files were copied to two separate diskettes (labelled Copy #1 and Copy #2) for storage and subsequent data reduction and analysis. Thus, two complete sets of copies on separate sets of diskettes were made for each day's tests. The diskettes were fully labelled with the project number and the filenames for the data files, and they were write-protected. After copying to diskettes, the original files on the hard drive of the data-acquisition computer were deleted to conserve hard-disk space. The data-acquisition computer was in a limited-access laboratory that was locked during non-working hours. The two identical diskettes were stored in separate diskette boxes in a limited-access office that also was locked during non-working hours. Each roll of exposed film from the testing was developed into a proof sheet. The proof sheet was labelled with the appropriate test date(s) and was then stored in the project file. The data sheets with the measured DSD filament diameters were placed in a binder and stored in the project file.

The data reduction-and-analysis procedure involved the processing of the raw data from each droplet-evaporation test. This procedure did not alter the raw data in any way; therefore, the raw data can be subjected to another data reduction-and-analysis procedure that may be required at a later time. The data reduction-and-analysis procedure involved the generation of a computer spreadsheet file for each test using the raw data. From the spreadsheet file, a formatted table and two different graphs of the experimental data could be printed. The final output of this data reduction-and-analysis procedure was the spreadsheet file and the printed table and graphs. The summary of the reduced data and any additional analysis of the test data (in addition to the analysis of the raw data for the individual tests) were not routine procedures and, therefore, are described in Section 9.

To reduce and analyze the raw data for a droplet-evaporation test, all of the corresponding raw data for the test were taken to the computer to be used to generate the spreadsheet file. Copy #2 of the data diskette was used. The data file from the test to be analyzed was copied to the hard drive of the computer. (The diskette was not affected.) Using Lotus 1-2-3, Release 3.1+, the data were imported into a 1-2-3 worksheet. The resulting raw-data spreadsheet was immediately saved as a .WK3 spreadsheet file with the same filename as the original raw data file. The spreadsheet file entitled Z-MACRO.WK3 was opened after the test worksheet. With the data worksheet active, the macro ALT-z was run on the worksheet to process the data. As the macro processed the data, it prompted the user for all required information from the handwritten checklists, for the number of droplets in the initial photograph of the droplets, and for the average filament diameter for the DSD that was used. After the macro was finished, the user checked the tabulated data and the calculated values. The user verified that the macro selected the best data points for the calculations. If necessary; different data points were selected for the calculations, and the appropriate changes were made in the worksheet. No raw data values were changed; only worksheet addresses to be used in calculations were changed if doing so was justifiable.

After the worksheet for a given test was completed, the spreadsheet file was stored to the computer hard drive. This file was then copied to a labelled floppy diskette that was write-protected and kept in a temporary safe place until archived. When needed, the tabulated data and two graphs of the reduced data were printed from the saved spreadsheet file. The printed table and graphs were stored in a binder.

9. RESULTS OF DROPLET-EVAPORATION TESTS

9.1 Description of Raw Data

As previously described in Section 8, the specific raw data for each droplet-evaporation test consisted of the following items:

- daily checklist for the test system (applicable to all tests run on a given day)
- checklist (and data form) for the test
- raw data file
- test photographs
- average measured DSD filament diameter (applicable to all tests performed with the particular DSD)

In addition, various logbooks for the test substances and for the laboratory equipment contained important information applicable to the testing. (With regard to GLP standards, the raw data for STDF Study P91-001 includes all

information related to the actual testing of the SDTF range-finding solutions.)

The daily checklist was used to document the startup of the test system and to record the initial setting of test parameters for the day. The test checklist was used to document the stepwise performance of a test and to record details and test parameters applicable to the test. The raw data file was the file generated by the data-acquisition computer during a test. The raw data file contained the data that were recorded by the data-acquisition system during the test. The raw data file is described further in the next section. The photographs taken during each test documented the number of drops in the test and the end of the test. (Additional photographs were taken in some of the tests to document the appearance of the droplets as a function of time.) The roll of film used when taking photographs was developed into a one-page proof sheet. The proof sheet typically contained photographs from several tests. Most of the photographs in each proof sheet were imprinted automatically by the camera databack with sequential photograph numbers. Before a series of tests on a given day, the first photograph(s) taken was imprinted with the date to be sure that the proof sheet could be properly identified after being developed. The average filament diameter for each DSD that was used was measured and recorded separately from the testing.

9.2 Description of Reduced Data

Appendix A shows an example of raw test data that were imported into the spreadsheet program and printed without any changes to the imported data. The data-acquisition software was set up to record the readings from eight analog channels as a function of date and time. Appendix A shows exactly how the raw data were recorded by the data-acquisition computer. The raw data file for each test was reduced and analyzed as described in Section 8.8. In general, the data reduction involved the use of the spreadsheet program and a custom-written macro to automatically reduce the raw data file. The macro performed exactly the same steps on all data files. The spreadsheet macro automatically prompted the person performing the data reduction for all of the necessary inputs from the other raw data (i.e., test and parameter information from the checklists, the number of droplets from the first photograph of the droplets, and the average DSD filament diameter). The spreadsheet macro performed all of the necessary tabulating, formatting, calculations, and graphing of the test results. The macro prepared a table and two graphs of the reduced data.

When ready for hardcopy of the test results, another simple spreadsheet macro was used to print the table and to plot the two graphs prepared by the data-reduction macro. Appendix B contains an example of the printed and plotted reduced data from a droplet-evaporation test. The reduced test results in Appendix B are actually the reduced data from Appendix A. Appendix B shows the reduced data exactly as they were generated by the spreadsheet program -- a table followed by two plots of the test data.

The data in Appendix B are for an ambient droplet-evaporation test (Case-1 test) without airflow. Appendix C contains an example of a standard

droplet-evaporation test (Case-2 test) with airflow. Most of the tests that we performed were standard tests.

As previously described and as shown in Appendixes B and C, the printed reduced data for each test consists of a table and two plots. The table lists on each page (for easy reference) specific information for the test including all inputted values (prompted for by the spreadsheet macro) and all important calculated values. The information at the top of each page is followed by the running tabulated data for the test. The values in the table are either values directly from the raw data file or values calculated from the raw data. Following the table, the two plots show the graphed data from the test. The various elements of the reduced data are described in more detail in the following paragraphs.

Each printed table of reduced data includes listings of the following data with the corresponding table headings:

- The Elapsed Time, sec is the running test time calculated from the absolute times recorded during the test.

- The Microbalance Mass, μg is the output from the microbalance during the test.

- The Meter Temperature, °F is the temperature of the air stream measured upstream of the DSD for standard droplet-evaporation tests. For ambient tests (no airflow), the meter temperature is the measured temperature inside the test chamber.

- The Meter Relative Humidity, % is the relative humidity of the air stream measured upstream of the DSD for standard droplet-evaporation tests. For ambient tests (no airflow), the meter RH is the measured RH inside the test chamber.

- The Drop Temperature, °F is the air temperature measured immediately below the drop location.

- The Calculated Drop Relative Humidity, % is the relative humidity of the air immediately below the drop location. This RH is calculated from the meter temperature, the meter RH, the drop temperature, and an RH conversion factor from a table of RH values versus temperature.

- The Microbalance Temperature, °F is the measured air temperature inside the vacuum bottle of the microbalance.

- The Flow Rate, L/min is the total flow rate of air through the test system during the test. (The measured air velocity during the test depended on the flow rate.)

- The Photo Switch Voltage, V is the voltage from the switch circuit used to mark the time at which photographs were taken.

- The Spray Switch Voltage, V is the voltage from the switch circuit used to mark the time at which the droplets were sprayed onto the DSD filaments.

The most important reduced tabulated data are the elapsed time, the microbalance mass, the drop temperature, and the calculated drop RH. The elapsed time and the microbalance mass were used by the spreadsheet macro to calculate the initial droplet properties and the overall evaporation rate (see below). The drop temperature and the drop RH document the actual exposure conditions (in addition to the air velocity) in the test. The photo-switch voltage was used to determine points to be used to calculate the initial droplet properties and the overall evaporation rate. The spray-switch voltage documents the spray time. The meter temperature and the meter RH were used with the drop temperature to calculate the drop RH. (Remember that in the standard tests, the meter temperature and meter RH were the measured temperature and RH of the air stream in the three-neck flask upstream of the test chamber; but in the ambient tests, the meter temperature and meter RH were measured inside the test chamber.)

The microbalance temperature and the flow rate were not important experimental parameters, but they were measured and recorded to verify the proper operation of the test system during the tests. (The flow rate was not meaningful for the ambient tests.) These parameters could possibly indicate problems with the microbalance or the flow system. These values could also possibly be used to explain any anomalies in the test data caused by changes in the microbalance temperature or the air velocity (as indicated by the flow rate).

At the end of the tabulated data, the spreadsheet macro calculates and gives the average values for the measured temperatures, relative humidities, and the total system flow rate during the entire test. It is very important to note that the applicability of the *average* values depends on the type of test that was conducted. The spreadsheet macro used to reduce the test data did not distinguish between the two types of tests and treated the data for each test in the same manner.

For standard tests, the average drop temperature and the average drop RH are the average values with the airflow turned both on and off, and therefore, these average values do not have any real meaning. To determine the applicable average drop temperature and average drop RH during exposure in a standard test, one must go to the individual tabulated data and calculate the average values during the exposure period (or during the pre-equilibration period). For an ambient test, the average drop temperature and average drop RH are applicable because they were the average values of the temperature and RH at the drop location inside the test chamber during the test.

The Photo Switch Voltage, V is the voltage from the switch circuit used to mark the time at which photographs were taken.

The [illegible] Switch Voltage, V is the voltage from [illegible] circuit used to mark the time at which [illegible] data were [illegible] once [illegible] film.

The most important reduced [illegible] based [illegible] the elapsed time [illegible] with the drop temperature [illegible] calculated drop RH. The elapsed time and the [illegible] were used [illegible] the spreadsheet macro to calculate the initial drop [illegible] ratio test [illegible]). The drop temperature [illegible] actual exposure [illegible] (in addition to [illegible] the photo-switch voltage was used to determine [illegible] calculate the initial droplet properties [illegible] the spray [illegible] during the spray [illegible] the [illegible] temperature and the [illegible] were [illegible] with the drop temperature to calculate [illegible] RH. [illegible] standard tests the [illegible] temperature [illegible] were [illegible] temperature and RH of [illegible] room [illegible] back flow [illegible] of the test [illegible]; but in the [illegible] tests [illegible] temperature and more RH were measured inside the [illegible].

The microbalance temperature [illegible] are not important experimental parameters [illegible] were measured [illegible] proper operation of [illegible] test [illegible] during the [illegible] was not meaningful for the [illegible] test. These parameters would possibly indicate problems with the microbalance [illegible] flow [illegible] possibly be used to [illegible] in the microbalance temperature or the air velocity as indicated by the flow rate).

At the end of the tabulated data, the spreadsheet macro calculates and gives the average values for the measured properties, relative [illegible] and the [illegible] system flow rate during the entire test. It is very [illegible] to note that the applicability of the average values depends on the test that was conducted. The spreadsheet macro used to [illegible] the [illegible] did not distinguish between the two types of tests and treated each test in the same manner.

For standard tests, the average drop temperature and the average [illegible] are the average values with the airflow turned both on and off, and [illegible] these average values do not have [illegible] meaning. To determine the average drop temperature and average drop RH during exposure [illegible] must go to the individual tabulated data and calculate [illegible] period (or during the [illegible] period) [illegible] average drop temperature and average drop [illegible] the average values of the temperature and [illegible] test chamber during the test.

For both the standard and ambient test cases, the average meter temperature and the average meter RH are not very useful values, but they do provide some indication about how the test system performed from one test to another.

For both the standard and ambient test cases, the average microbalance temperature is applicable, but the specific value of the average microbalance temperature is not very significant. The average measured flow rate is applicable for standard tests, but the specific value of the measured flow rate for the standard test case is also not significant. The average microbalance temperature and the average flow rate could be used to compare the performance of the test system between tests. For ambient tests, the average measured flow rate is not meaningful because the system airflow was directed away from the drop location during the test. During some ambient tests, the flow rate that was measured was zero because the flow system was turned off, and in other ambient tests, the flow rate that was measured was nonzero because the flow system was turned on to pre-equilibrate for standard tests. In either situation, the average measured flow rate does not matter in the reduced data for ambient tests because the airflow was not directed at the droplets.

The information given at the top left of each printed page of the reduced-data table was prompted for by the spreadsheet data-reduction macro and was input by the person performing the data reduction. This information includes the following:

- The <u>Test Number</u> is the test number that was assigned when the test was conducted.
- The <u>Substance</u> is the test substance -- one of the three SDTF range-finding solutions.
- The <u>Target Drop Size</u> is the desired drop size (in μm) for the test.
- The <u>Target Air Velocity</u> is the preset air velocity (in ft/min) for the test.
- The <u>Target Temperature</u> is the desired temperature (in °F) for the test.
- The <u>Target RH</u> is the desired relative humidity (in %) for the test.
- The <u>Initial # of Drops</u> is the number of suspended droplets on the DSD filaments immediately after the droplets were sprayed onto the filaments and the DSD was hung from the microbalance.
- The <u>Average DSD Fiber Diameter in μm</u> is the average filament diameter measured for the DSD that was used for the test.

- The <u>Test-Substance Density in g/mL</u> is the density of the test-substance.

With regard to the test parameters that were input into the spreadsheet for each test, the target drop size (100, 250, or 400 μm) determined both the spray time and the air velocity that we used (see Section 9.4). The initial number of droplets for each test is the number of droplets counted in the initial photograph that was taken of the droplets during the test. Figure 7 shows an example initial photograph of the droplets suspended on the DSD filaments in one of the droplet-evaporation tests. This photograph is actually the photograph that goes with the example test results given in Appendix C. The test-substance density was calculated from the known mixture composition and the density of the test-substance components at room temperature.

The information given at the top right of each printed page of the reduced-data table was calculated by the spreadsheet data-reduction macro using the raw data and inputted information. This information includes the following:

- The <u>Initial Drop Time, s</u> is the elapsed time located by a search of the tabulated data for the time corresponding to when the first photograph of the droplets was taken, as marked by the photo switch.

- The <u>Initial Total Mass, μg</u> is the microbalance mass corresponding to the initial drop time.

- The <u>Average Initial Drop Mass, μg</u> is equal to the initial total mass divided by the initial number of droplets.

- The <u>Average Initial Drop Size, μm</u> is calculated from the average initial drop mass, the test-substance density, and the average DSD filament diameter. Spherical drops suspended on the DSD filaments are assumed in the calculation, and corrections are made for the filament diameter.

- The <u>Ending Evaporation Time, s</u> is the elapsed time located by a search of the tabulated data for the time corresponding to when the last photograph of the droplets was taken, as marked by the photo switch. The last photograph was taken at the moment when the droplets were observed to have almost completely evaporated in the standard tests (and after the airflow was turned off) or at the moment when the droplets appeared to evaporate completely in the ambient tests.

- The <u>Ending Total Mass, μg</u> is the measured mass corresponding to the ending evaporation time.

- The test-substance density in g/mL is the density of the test substance.

With respect to the test parame[illegible]s that were input into the spreadsheet for each test, the target drop s[illegible] (100, [illegible]0, [illegible] [illegible]00 µm) determined both the entry time and the air velocit[illegible] [illegible]se[illegible] [illegible] [illegible] [illegible] (see Section [illegible] [illegible]). Th[illegible] initial number of droplets for each test is [illegible] number [illegible] droplet count [illegible] in the initial photograph that was taken of [illegible] droplets [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]re [illegible] shows an example initial photograph of the droplets suspended on the [illegible] filaments in one of the droplet-evaporation [illegible]. This [illegible] is actually the photograph that goes with the example test results given in Appendix C. The test-substance density was calculated from the known mixture composition and the density of the test substance components at room [illegible].

The information [illegible] [illegible] [illegible] [illegible] of each printed reduced-data table was calculated [illegible] spreadsheet [illegible] data [illegible] [illegible] using the raw data and [illegible] [illegible]. This information includes the following.

- The Initial D[illegible] [illegible] [illegible] [illegible] the elapsed time located by a search [illegible] [illegible] [illegible] [illegible] data [illegible] the [illegible] corresponding to when the first photo[illegible] of the droplets was taken, as [illegible] by the photo switch.

  The Initial Total Mass, µg [illegible] the microbalance mass corresponding to the initial drop time.

- The Average Initial Drop Mass, µg is equal to the initial total mass divided by the initial number of droplets.

- The Average Initial Drop Size, µm is calculated from the average initial drop mass, the test-substance density, and the average DSD filament diameter. Spherical drops suspended on the DSD filaments are assumed in the calculation, and corrections are made for the filament diameter.

- The Droplet Evaporation Time, s is the elapsed time located by a search [illegible] the tabulated data [illegible] [illegible] time corresponding to when the last photograph of the droplets was taken, [illegible] marked by the photo switch. The [illegible] photograph was taken at the [illegible] when the droplets were [illegible] [illegible] [illegible] completely evaporated in the standard test [illegible] [illegible] after the [illegible] was turned off [illegible] at the moment when the droplets [illegible] [illegible] completely in the [illegible] [illegible] tests.

[illegible] is the measured mass correspond[illegible] [illegible]e.

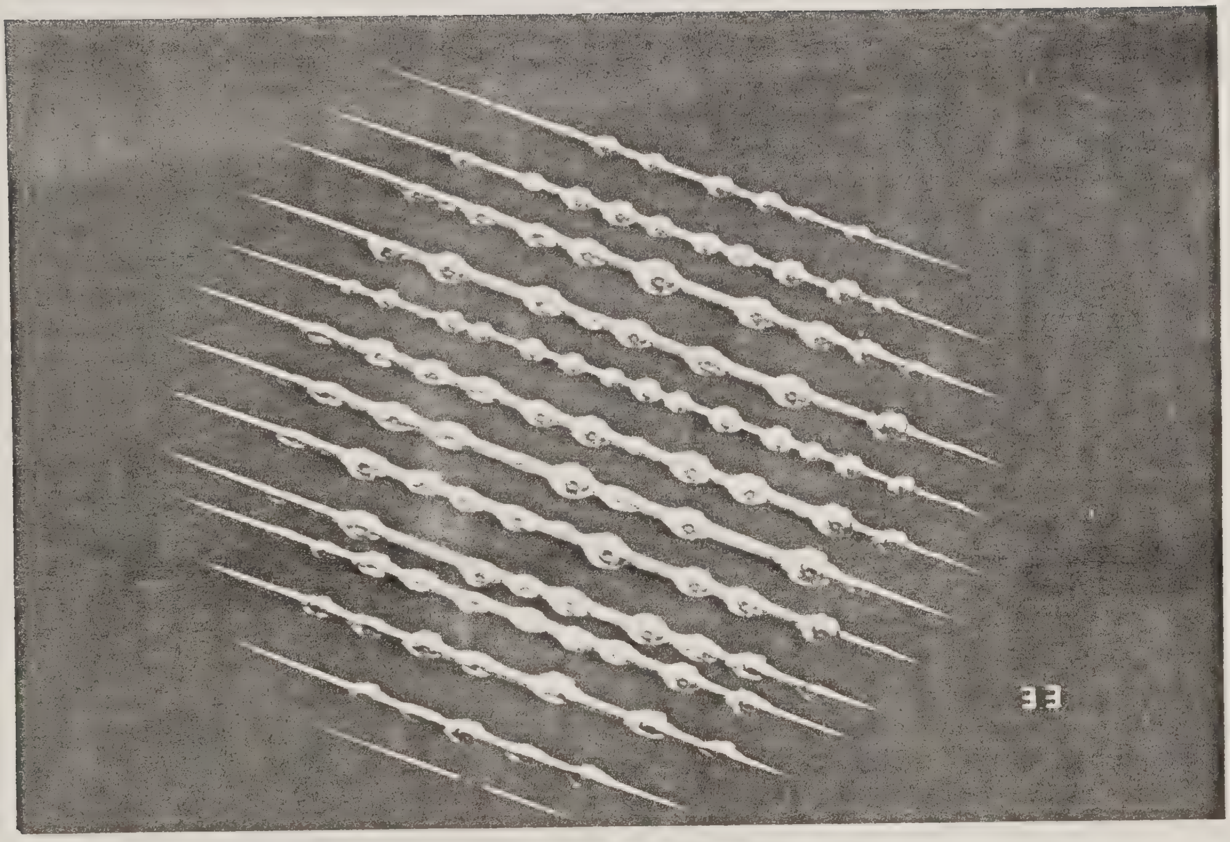


Figure 7. Example initial photograph of droplets suspended on the DSD (from Test 110392F).

- The Overall Evaporation Period, s is the calculated difference between the initial drop time and the ending evaporation time.

- The Total Mass Loss, μg is the calculated difference between the initial total mass and the ending total mass.

- The Overall Evaporation Rate, ng/s is the evaporation rate per droplet and is calculated using the total mass loss, the overall evaporation period, and the number of droplets.

For each test reduced by the data-reduction spreadsheet macro, the macro performed all calculations. The macro generally selected the best initial drop time and the best ending evaporation time; and consequently, the best initial total mass and the best ending total mass were also selected. However, the macro did not always select the best points for the calculations. In some cases, the best values were not automatically selected because the photo switch may not have been switched at the best or correct moment during a test. In a few tests, the photo switch was accidently switched at the wrong time or was switched too fast to be picked up by the data-acquisition system. The most common problem with the automatic selection of times was that the corresponding mass values were obviously noise spikes in the raw data. In these latter cases, we merely selected better times near the automatically selected times. When we changed the times used in the calculations, we also changed the mass values that were used in the calculations to the values corresponding to the newly selected times. It is very important to understand a few key points. The fact that the macro may not have automatically selected the best times and corresponding masses for the calculations does not make the mass-versus-time data any less valid regardless of any problem with the photo switch. Also, we did not actually change any data values in the spreadsheet; we only changed the spreadsheet cell addresses used in the calculations so that the best data would be used. The original data values were never changed in the reduced spreadsheet.

The data from a droplet-evaporation test can be examined most easily by looking at the two plots for each test. As shown by the example plots at the end of Appendixes B and C, the first plot for each test presents the mass-versus-time data overlapped by the spray-switch and photo-switch voltages to indicate when the droplets were sprayed and when the photographs were taken during the test. The second plot for each test shows the meter temperature, the meter RH, the drop temperature, the drop RH, the balance temperature, and the flow rate.

The spreadsheet program that was used to generate the plots for the droplet-evaporation tests displays the graphed data in different colors so that the data in the plots can be easily examined. Unfortunately, the spreadsheet program that we used cannot graph data using different line types, and thus, the data cannot be easily distinguished in the printed black-and-white plots. For description purposes, Figures 8 and 9 show re-plots of the plots in Appendixes B and C. Figures 8 and 9 were prepared by importing the plots from the reduced data files into another software program from which

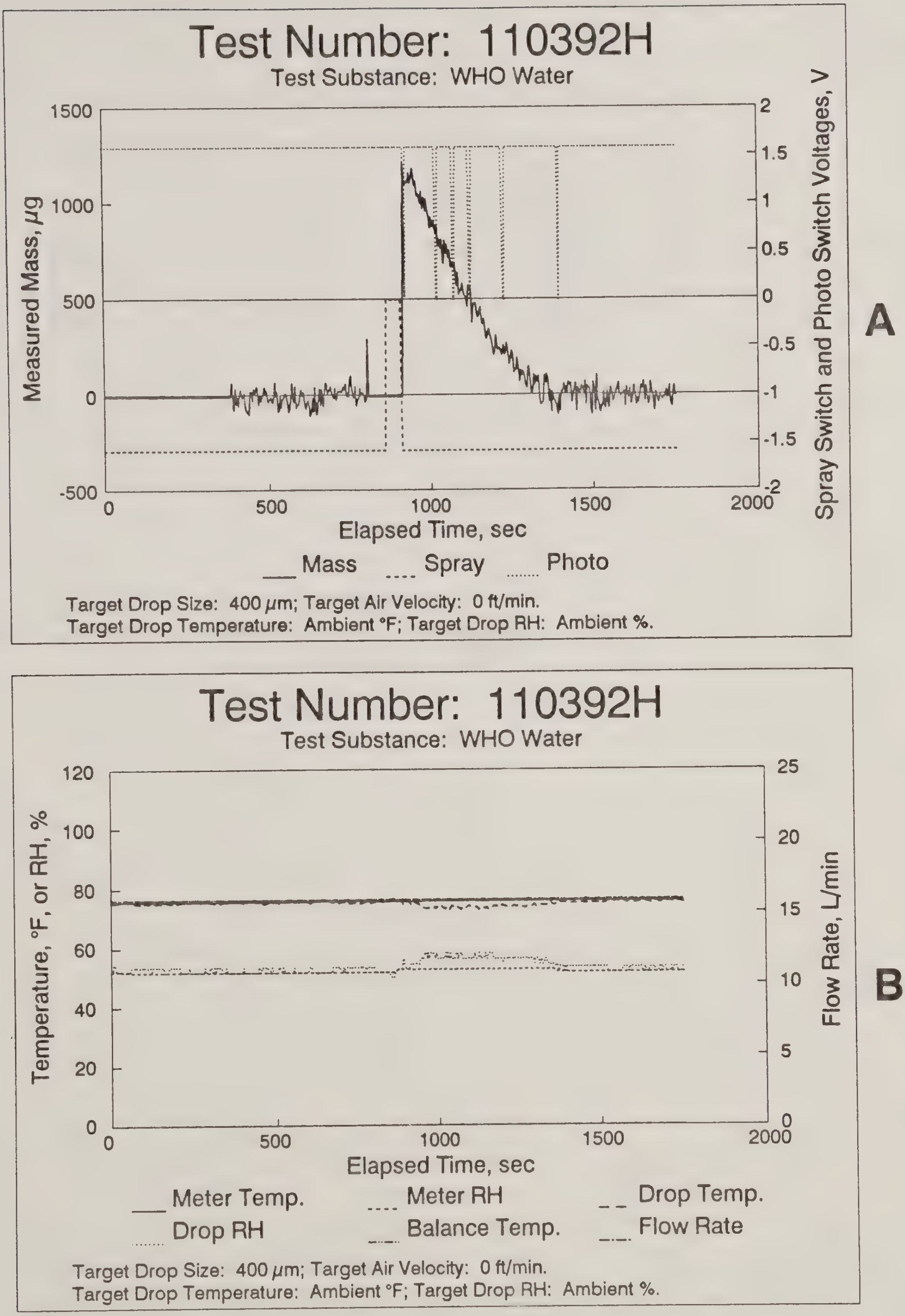
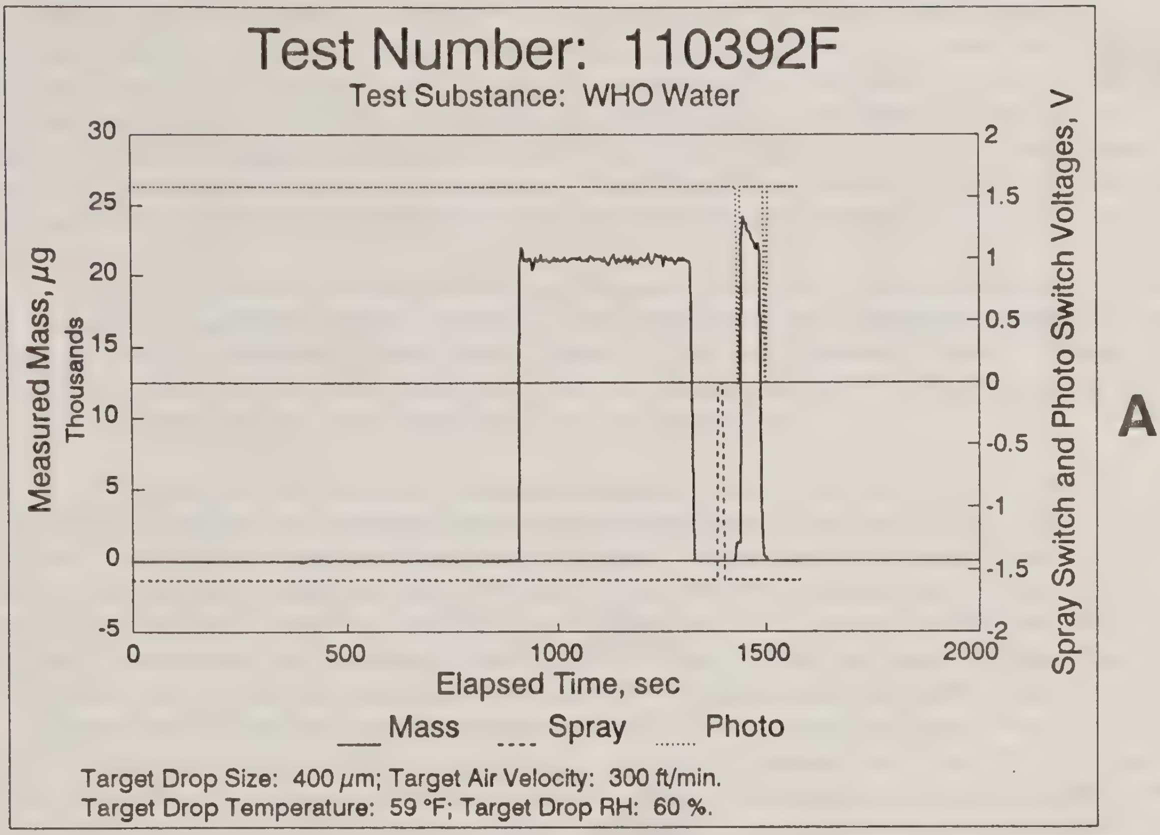


Figure 8. Example plots from an ambient droplet-evaporation test.



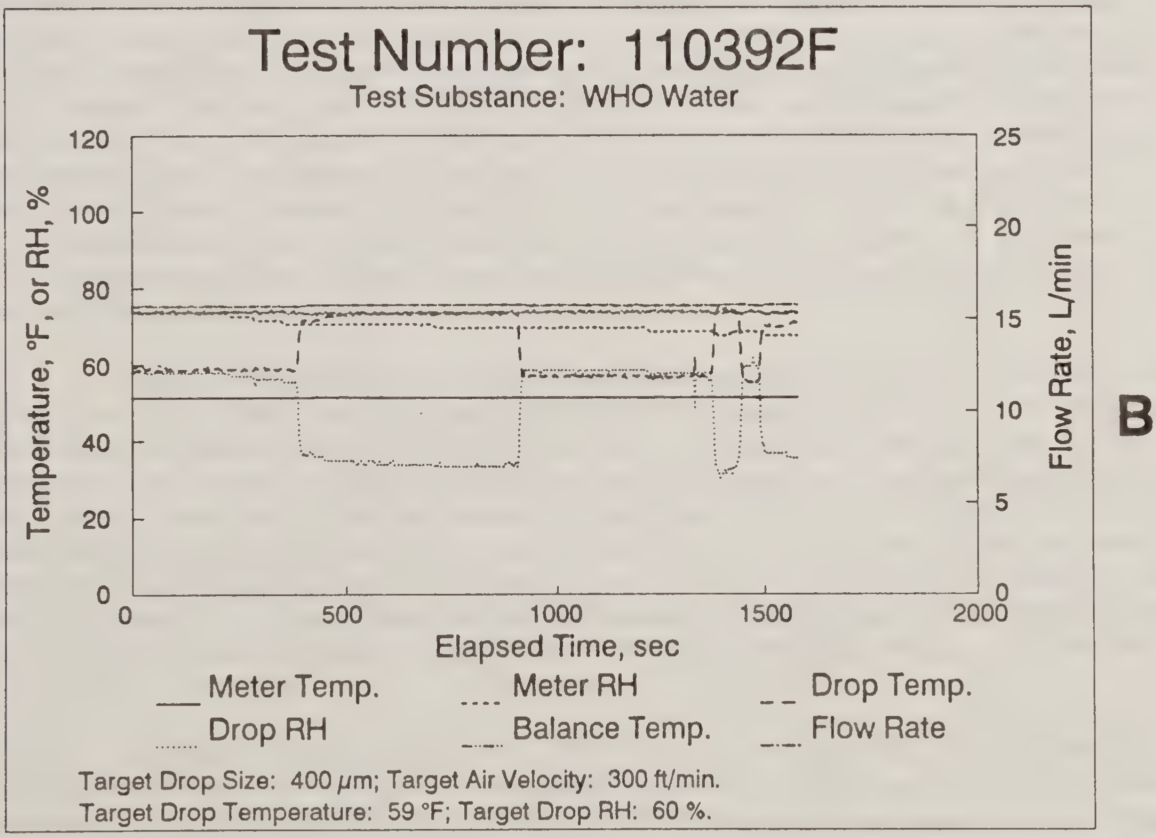


Figure 9. Example plots from a standard droplet-evaporation test.

more distinct graphs were prepared. This process was too time-consuming to prepare such plots for all of the droplet-evaporation tests, but this effort was not necessary because all plots were examined on screen in color for any significant problems with the test data. Even the black-and-white plots printed by the spreadsheet program can be used to look for any significant problems with the test data. Moreover, the black-and-white plots still allow quick examination of the recorded data for important features in the data.

To explain the differences between the data generated for a test without airflow (ambient test) and a test with airflow (standard test), refer to Figure 8 for an ambient test and Figure 9 for a standard test. Both of these figures have an A plot and a B plot corresponding to the first and second plots produced by the data-reduction procedure.

Figure 8A shows the measured mass (recorded output of the microbalance) during an ambient test as a function of time after the data file was created and data acquisition was started. The mass-versus-time data show that the microbalance output was switched to SHORT initially. Then the microbalance was switched to OUTPUT for a period to record baseline data with the dry DSD attached to the hangdown wire of the microbalance. The baseline data verified that the balance was properly zeroed with the DSD before the test. Immediately before the DSD was removed, the microbalance was again shorted. During this period, the droplets were sprayed on the DSD as shown by the spray switch. As soon as the droplets were finished being sprayed onto the DSD filaments, the DSD was re-hung and the microbalance was switched to record the mass. Figure 8A then shows the measured mass of the droplets as they evaporated. As soon as possible after the DSD was re-hung and the balance was switched to OUTPUT, an initial photograph of the droplets was taken to record the initial number of droplets and to correlate with the initial mass of the droplets. In the ambient tests, additional photographs were taken during the course of evaporation in hopes of following the evaporation of the droplets optically. At the moment that the droplets visually evaporated completely, another photograph was taken to document the ending evaporation time. The times at which the photographs were taken are also documented in Figure 8A.

Figure 8B shows the other test parameters as a function of time during the test. (The x-axis time scale is the same in both plots in Figure 8 to facilitate comparisons between the plots.) Figure 8B shows that the temperatures and relative humidities during the test were practically constant with no significant drift up or down during the test. It is hard to see in the plot, but the measured flow rate throughout the test was zero because the test was one without airflow. The measured flow rate during an ambient test was not applicable anyhow, because as previously mentioned, the flow system was configured to direct flow away from the test chamber during an ambient test.

Figure 9 demonstrates how the data generated in a standard test differ from the data generated in an ambient test. The key difference between the tests was that in a standard test the droplets were exposed to airflow at a high air velocity. The airflow caused a significant measured drag on both the DSD and the droplets. (At an air velocity equal to the terminal velocity

of the droplets, the drag on the droplets would equal the weight of the droplets.) Because of the drag effect and because of the increased noise level when the airflow was turned on, the mass of the droplets had to be measured immediately before and immediately after exposure to the airflow to determine the mass loss during the exposure period.

Figure 9A shows the measured mass (recorded output of the microbalance) during a standard test as a function of time after the data file was created and data acquisition was started. The mass-versus-time data shows that the microbalance output was switched to SHORT initially. The microbalance was then switched to OUTPUT for a period to record baseline data with the dry DSD attached to the hangdown wire of the microbalance. The baseline data verified that the balance was properly zeroed with the DSD before the test. After sufficient baseline data were recorded, the airflow was directed through the microbalance hangdown tube onto the DSD. The system was then allowed to pre-equilibrate for a period. Figure 9A shows the drag weight of the dry DSD. Immediately before the DSD was removed, the microbalance was again shorted. During this period, the droplets were sprayed on the DSD as shown by the spray switch. As soon as the droplets were finished being sprayed onto the DSD filaments, the DSD was re-hung and the microbalance was switched to record the initial mass of the droplets without airflow. The initial droplets were also photographed at this time as shown by the photo-switch voltage.

After the initial mass was measured and the initial photograph of the droplets was taken, the airflow was turned on. The mass-versus-time data in Figure 9A show the combined weight of the droplets, the drag on the droplets, and most significantly, the drag on the DSD. The evaporation of the droplets is exhibited in the figure. When the droplets had almost completely evaporated, the airflow was turned off (redirected) and another photograph was taken to document the ending evaporation time. The final mass of the droplets was also recorded by the data-acquisition computer at this point.

Figure 9B shows the other measured test parameters during the test. The difference in the temperature and RH of the air stream and of the ambient air in the test chamber is apparent. By comparing Figure 9B with Figure 9A, it can be seen that the air stream temperature and RH were very close to the target values. When the air stream was directed away from the test chamber, the measured drop temperature rose to the ambient temperature in the test chamber. It is important to note that in the reduced data for the standard droplet-evaporation tests, the drop RH is not meaningful when the air stream was turned off. That is, the drop RH is not a measured value but a calculated value based on the temperature and RH of the air stream and on the drop temperature. When the air stream is turned off, the calculated drop RH changes because the measured drop temperature changes. There was no direct or indirect measurement of RH in the test chamber during the standard tests. (In the ambient test, the meter temperature and the meter RH are the measured values inside the test chamber.)

Examination of Figures 8 and 9 also shows some other characteristic behavior that we observed during the testing. Because the drop temperature was measured immediately below the drop location (but still in the

air stream for standard tests), the measured temperature was sometimes affected to a small extent by the evaporation of the droplets. Because of the cooling effect of the droplet evaporation during a test, the temperature of the air below the suspended droplets was cooler as measured by the drop-temperature thermocouple. This effect is apparent in Figures 8B and 9B. Because the measured drop temperature was slightly lower, the calculated drop RH was slightly higher.

9.3 Summary of Test Results

Table D-1 in Appendix D presents the results of all of the completed droplet-evaporation tests of the SDTF range-finding solutions. (Tests that had to be aborted for one reason or another are not included in the table but are documented in the raw data.) Table D-1 gives for each droplet-evaporation test the test substance, the test number, the target temperature, the target drop size, the target relative humidity, the test air velocity, any pertinent comments, the experimentally determined average drop size, and the experimentally determined overall evaporation rate (for a single droplet). The calculated average drop size and overall evaporation rate for each test in Table D-1 were taken from the corresponding table of reduced data for the test.

The summarized results of the droplet-evaporation tests are also presented in the plots in Appendixes E and F for ease of discussion. The figures in Appendix E show overall evaporation rate plotted versus air velocity at different relative humidities for each combination of test substance, target temperature, and target drop size (and are presented in that order). The figures in Appendix F show overall evaporation rate plotted versus experimental drop size for each combination of test substance, target temperature, and target RH. The test results in Table D-1 and the plots in Appendixes E and F are discussed in Section 10.

9.4 Comments on Test Data

As discussed in Section 6, we were not able to determine evaporation rate as a function of time for the SDTF range-finding solutions that we tested because the test substances evaporated too quickly under airflow. We did, however, measure the overall evaporation rate for the three test substances under almost all of the test conditions specified for Task TA-31. (See below for the conditions that we were unable to use.) In addition to varying the drop size, temperature, and relative humidity, we also varied the air velocity for each target drop size when conducting the WHO-water tests. Based on theoretical considerations (see Section 6) and the results of the WHO-water tests (see Section 10 for a discussion), we used only one air velocity per drop size for the tests of the Sulfur 6L mixture and the Thuricide mixture.

The air velocities that we used in the droplet-evaporation tests for the three target drop sizes were based on the terminal velocities for water drops (density = 1 g/mL). The air velocities and the corresponding percentages of the terminal velocities for the target drop sizes were as follows:

Target Drop Size, µm	Terminal Velocity, ft/min	Test Air Velocity, ft/min	Percentage of Terminal Velocity
100	53	30	57%
		40	75%
		50	94%
250	186	125	67%
		150	81%
		175	94%
400	318	200	63%
		250	79%
		300	94%

The number and initial size of the droplets generated in each test depended on the test substance, the atomizer, the nitrogen pressure and flow rate delivered to the atomizer, the average DSD filament diameter, and most importantly, the spray time. The atomizer itself was not really a variable because the same make of atomizer was used for all of the tests, but the spray from the atomizer exhibited some variability. Overall, the generation of droplets was similar for all three test substances. Around 100 suspended droplets were typically produced in each test.

We used three different DSDs with average filament diameters between 80 and 100 µm for the 250- and 400-µm target drop sizes. (Each of these three DSDs was used for both of the two larger drop sizes.) We used one DSD for the 100-µm target drop size, and this DSD had an average filament diameter of about 50 µm. It should be noted that the diameters of the filaments on each of the four DSDs varied significantly (on a given DSD). For a given DSD, the relative standard deviation of the thirteen filament diameters was as much as 30%.

For WHO water, the respective spray times that we used to try to generate the target drop sizes of 100, 250, and 400 µm were 3, 4, and 6 s. The various spray parameters for the Sulfur 6L mixture and the Thuricide mixture had to be varied somewhat to generate droplets similar in size to those for WHO water. We tried to keep the spray times as constant as possible for each target drop size during the droplet-evaporation testing, but the spray times generally had to be increased by a second or two (relative to those for WHO water) to spray the "thicker" Sulfur 6L mixture and the Thuricide mixture.

Here are some additional facts and comments regarding the droplet-evaporation test data:

- We did not conduct tests with the smallest droplet size (target drop size = 100 μm) at the highest temperature (target temperature = 40 °C or 104 °F) because the droplets evaporated too quickly at 40 °C to be reliably measured with the test method.

- We did not conduct tests at the lowest temperature (target temperature = 15 °C or 59 °F) and the highest relative humidity (target RH = 90%) because the highest relative humidity that could be achieved at 15 °C with the test system was approximately 60%.

- The tests with WHO water were performed in triplicate; the tests with 25% Sulfur 6L/WHO water and with 50% Thuricide 48LV/water were performed in duplicate.

- As previously mentioned, the tests with WHO water were conducted using three different fixed air velocities per target drop size, but the tests with the Sulfur 6L mixture and the Thuricide mixture were conducted with one fixed air velocity per target drop size. The air velocities used for the Sulfur 6L mixture and the Thuricide mixture were the intermediate air velocities used for WHO water.

- The temperature of the exposure airflow in the standard tests was typically controlled within ±2 °F of the target temperature.

- The relative humidity of the exposure airflow in the standard tests was typically controlled within ±5% of the target RH for the tests conducted at 30% or 60% RH. For the standard tests conducted at 90% RH, we typically maintained the relative humidity between 80% and 90%.

10. DISCUSSION

As described in the previous section of this data report, the summarized results of the droplet-evaporation tests with WHO water, 25% Sulfur 6L/WHO water (by volume), and 50% Thuricide/water (by volume) are presented in Table D-1 (Appendix D). For comparison and discussion purposes, the test results are also plotted in Figures E-1 through E-24 (Appendix E) and in Figures F-1 through F-24 (Appendix F). Under Task TA-31, Southern Research Institute was not required to provide a detailed analysis of the test results; however, we offer a limited discussion of the results from our perspective because we conducted the tests and reduced the data into a useable form.

Both the Sulfur 6L mixture and the Thuricide mixture were tested as more dilute mixtures with water than originally planned, but the test substances had to be diluted to be sprayed or to produce acceptable suspended droplets. Regardless of the additional dilution that was required, both test substances can serve as range-finding solutions to characterize droplet evaporation of "pesticide-like" substances.

The comments given in Table D-1 indicate that some tests had initial total drop masses that were lower or higher than in analogous tests, but the results should still be valid for the drop sizes that were actually produced in these tests. The tests that are noted in Table D-1 to be questionable or possibly questionable (as denoted by "?") were tests in which there was some minor problem during the test. In all of these cases, however, the reduced data do not exhibit any significant problem. In other words, we believe that all of the data given in Table D-1 are reliable until any further analysis (separate from Task TA-31) identifies obvious outliers in the data.

Table D-1 includes the results of the ambient tests that were conducted under ambient test-chamber conditions corresponding to the conditions in the test chamber when droplets were sprayed in the standard tests. The values given in parentheses are the average temperatures or relative humidities measured during the ambient tests. The results of these tests can be used to assess the extent of droplet evaporation during the short period between the time that droplets were produced and the time that droplets were exposed to airflow in the standard tests. The results for the ambient tests precede the standard tests to which they apply.

Although we did not analyze the data from the ambient tests to estimate the extent of drop evaporation in the standard tests before exposure to airflow, we feel that the effect was generally not significant with regard to the overall evaporation rates that we determined in the standard tests because the rate of evaporation was significantly higher in the tests with airflow and because the initial evaporation of the droplets appeared to be roughly linear (mass versus time). That is, we don't believe that the mass loss before the initial mass measurement was significant when compared to the mass loss during exposure to airflow. This belief may not necessarily be true for the tests conducted at 40 °C, however, because the ambient temperature in the test chamber was elevated. Using the same spray times as in the tests at 25 °C and 15 °C, the test results show that the measured initial drop sizes were smaller in the tests at 40 °C. The smaller initial drop sizes may indicate that significant evaporation occurred before the mass of the droplets was first measured.

Figures E-1 through E-8 show how the measured overall evaporation rates for WHO water varied with test air velocity and RH for a given target drop size and target temperature. As demonstrated in the figures, the evaporation rate was higher (as expected) for larger initial drop sizes and for higher temperatures. Also as expected, the evaporation rate was reduced at higher relative humidities. The effect of air velocity, however, is not readily apparent in Figures E-1 through E-8. Figures E-9 through E-24 show the results plotted in a similar fashion for the Sulfur 6L mixture and the Thuricide mixture, but the plots are not as useful because only one fixed air velocity was used per drop size for these latter two test substances. These figures do exhibit the effects of drop size, temperature, and RH on the evaporation rates for the Sulfur 6L mixture and the Thuricide mixture. The effects are analogous to those for WHO water.

As mentioned in the preceding paragraph, examination and comparison of the plots in Figures E-1 through E-24 show the significant

dependence of the overall evaporation rate on the initial drop size. (Note the change in the y-axis scale for plots corresponding to the three different target drop sizes.) These figures, however, do exhibit significant scatter in the test results. This scatter is mostly attributable to the actual drop sizes (as opposed to the target drop sizes) that were produced in the tests. This fact is discussed in more detail below.

Because of the significant scatter observed in the plots in Appendix E, the test data were re-plotted as shown in Figures F-1 through F-24 in Appendix F. These figures show the data plotted as overall evaporation rate versus the experimentally determined drop size for a given target temperature and target relative humidity. These figures also show how the measured drop sizes corresponded to the target drop sizes. The figures in Appendix F are much more informative than those in Appendix E and demonstrate that the initial drop size (the measured drop size) was a very important experimental variable. Although we typically used the same spray time for each test with a particular test-substance and target drop size, the average measured drop size varied significantly from test to test. That is, drop size was supposed to be a parameter that we controlled by controlling the spray time, but the drop size was actually another experimental variable. The plots in Figures F-1 through F-24 show a strong dependence of the measured evaporation rates on the initial drop size, which is not a surprising fact.

It is also important to note that the figures in Appendix F show that the experimental drop sizes varied considerably from the target drop sizes of 100 μm and 400 μm. Prior to the tests, we selected initial spray times based on limited preliminary studies with Milli-Q water. Because of the need to complete the tests quickly, we proceeded with the testing using one atomizer and fixed the spray times that were used in most of the tests so that the results of the tests could be compared with regard to spray time. The initial drop sizes also varied some with test substance. In general, the drop sizes produced ranged from about 200 μm to somewhat less than 400 μm. With the atomizer that we used, we were also limited in the range of spray times that we could use. A spray time of less than three seconds (the shortest spray time that we used) was almost impractical, and spray times that were too long produced very irregular-sized droplets that tended to fall off of the DSD filaments. To generate and support smaller or larger droplets, additional droplet-suspension devices with smaller or larger filaments would need to be prepared, and another atomizer may also be needed.

Comparison of the plots in Appendix F shows a real effect of temperature and relative humidity on the measured evaporation rates. The differences in evaporation between the three test substances are also apparent. WHO water generally evaporated the fastest of the three test substances followed by the Sulfur 6L mixture and then by the Thuricide mixture.

The most important value determined from each droplet-evaporation test was the overall evaporation rate that would be expected for a freely falling droplet with the corresponding initial drop size, which is best represented by the experimentally determined average drop size (see below for

[illegible] overall evaporation rate on the initial drop [illegible]

[illegible] scale, but after [illegible] to the [illegible]

[illegible] figures, however, do exhibit [illegible]

[illegible] scatter is [illegible] attributable to the [illegible]

(as opposed to the larger [illegible]) that were [illegible]

This fact is discussed in more detail below.

Because of [illegible] significant [illegible] observed [illegible]

Appendix E, the [illegible] we a [illegible]-plot [illegible]

in Appendix F. These figures [illegible] the [illegible]

rate var[illegible] the [illegible]

[illegible] size and [illegible]

[illegible] used drop [illegible] por[illegible]

[illegible] are much [illegible]

The initial drop [illegible]

[illegible] estimate[illegible] variable. [illegible] empirical [illegible]

[illegible] such a [illegible]

[illegible] drop size [illegible] That [illegible]

was supposed to be [illegible] controlled [illegible]

time, but the drop [illegible] experim[illegible]

In Figures F-1 through F-[illegible] [illegible] lence [illegible] measured

[illegible] rates [illegible] initial [illegible] is [illegible]

It is also [illegible] the [illegible] Appendix [illegible]

that the experimental [illegible] drop

sizes of 100 μm and 400 μm [illegible] spray

times based on [illegible] water. [illegible]

used to [illegible] with the [illegible]

[illegible] and fixed the [illegible] that [illegible]

the results of the tests could [illegible] regard to spray

[illegible] sizes also varied [illegible] the

sizes [illegible] about 200 μm [illegible] less than [illegible]

the atomizer [illegible] used, we were also limited [illegible]

that we could use. A [illegible] time of less than three seconds [illegible]

spray time that we used) was almost impractical, and spray times [illegible] were too

long, produced very irregular sized droplets that tended to fall [illegible] of the [illegible]

[illegible] and support smaller or larger [illegible]

[illegible] devices with smaller or larger filaments would [illegible]

[illegible] and another atomizer [illegible] also be needed.

C[illegible] of the plots in Appendix F shows [illegible] effect [illegible]

[illegible] relative humidity on the measured evaporation [illegible]

[illegible] between the three [illegible]

[illegible] generally [illegible] of the [illegible]

[illegible] followed by the [illegible] and then by the [illegible]

[illegible] from each droplet [illegible]

[illegible] would be expected [illegible]

[illegible] drop size, which [illegible]

[illegible] drop size (see below for

further discussion). Given the initial drop size for a particular test substance and the corresponding overall evaporation rate for particular environmental conditions (i.e., temperature and relative humidity), the lifetime of the droplet under free-fall conditions can be calculated. Assuming that the evaporation rate curve for the test substance is roughly linear and can be determined by the overall evaporation rate, the mass (and size) of the droplet as a function of time can be estimated. Based on such estimations, the changing rate of fall of a droplet can be predicted or the drift of the droplet under given meteorological conditions can be predicted. The reliability of such predictions would have to be verified in other studies.

The initial drop is best represented by the experimentally determined average drop size and not by the target drop size because of the variability observed in the measured drop sizes and the significant differences between the measured drop sizes and the target drop sizes. As previously discussed in this report, the actual drop sizes produced in the tests depended on several variables, the most important of which for a given test were the average DSD filament diameter and the spray time. The spray times were selected a priori based on some limited preliminary spray studies and on other practical limitations. Although the actual drop sizes produced were not as close to the target drop sizes as desired, the resulting experimental data are still useful.

A key assumption of the droplet-evaporation test method that we developed was that the fixed air velocity used in each test would produce an evaporation rate similar to that produced by the changing velocity of a freely falling droplet. Based on some theoretical predictions given in the Eighth Monthly Progress Report for Task TA-31, the evaporation curve for a freely falling droplet could be closely approximated by a curve generated under any fixed air velocity near the initial terminal velocity of the droplet. The results of the WHO-water tests that we performed also supported the prediction that different air velocities near the terminal velocity would produce similar evaporation results. That is, all of the test data for WHO water are plotted in Figures F-1 through F-8 without regard to the air velocity that was used in the tests and do not exhibit any scatter that could be attributed to the different air velocities. For these reasons, we used only one fixed air velocity per target drop size in the tests with the Sulfur 6L mixture and the Thuricide mixture.

Because the fixed air velocity used in each test was selected to be near the terminal velocity of a droplet having the target drop size, the fact that the average measured drop size in most of the tests was not near the target drop size means that the fixed air velocity that was used was not necessarily near the terminal velocity of the initial droplets. That is, the air velocities used in the many of the tests with a 100-μm target drop size were lower than the terminal velocity for the average measured drop sizes, while the air velocities used in the many of the tests with a 400-μm target drop size were higher than the terminal velocity for the average measured drop sizes. The consequence of this fact is that the overall evaporation rates measured in the tests with a 100-μm target drop size may be slightly low, and the overall evaporation rates measured in the tests with a 400-μm target drop

size may be slightly high. However, the apparent weak dependence of the test results on air velocity indicates that as long as there was sufficient airflow around the droplets, the overall droplet-evaporation rate was not strongly dependent on the magnitude of the airflow.

To summarize the applicability of the test data generated under Task TA-31 (or any data that may be generated in the future with the test method that we developed), the data will have to be carefully analyzed and used in trial calculations to determine their real value in making predictions about actual behavior in aerial spray applications. It is possible that the real value of the data will be for comparing the laboratory evaporation of different test substances so that reliable evaporation models based on test-substance composition can be developed. The latter idea is essentially the approach of the SDTF in selecting range-finding solutions. With this approach, field studies may only have to be limited to important range-finding solutions to establish the behavior of the range-finding solutions and other substances with similar physical properties.

11. RECOMMENDATIONS

Considering that we developed a novel method for measuring droplet-evaporation rates of small droplets under different conditions, we feel that the generated data are very good. Based on the test results and on our experiences while conducting the tests, we can make several recommendations to improve the test method to generate even better data.

- Improved droplet formation. The generation and suspension of the droplets for the tests needs improvement. DSDs with filaments of more consistent size would produce better data. Other filament materials should also be investigated.

- Test automation. Each droplet-evaporation test is simple in experimental concept but is complex to perform. Therefore, automation of the test (e.g., robotics) is desirable. The spraying of the droplets is a particularly difficult manual procedure. Adequate automation may also provide better control, better reproducibility, and may allow the testing of substances that evaporate more quickly than water.

- Faster data collection. Because the test substances evaporated so quickly under airflow, a faster data-acquisition system (computer and A/D board) would provide more data that would be sufficient for signal averaging (data smoothing).

- Automated data reduction and analysis. The detailed reduction and analysis of the raw test data was very time consuming even with the aid of a computer and a complex spreadsheet macro. More automated data reduction (and data smoothing as mentioned above) in real time during a test would be very beneficial.

- Improved photographic system. The use of a more sophisticated photographic system, preferably a video-camera system, should be considered to measure continuous droplet-evaporation curves (drop size versus time) for test substances under controlled environmental conditions.

12. ACKNOWLEDGMENTS

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APPENDIX A

EXAMPLE OF A RAW COMPUTER DATA FILE FROM A DROPLET-EVAPORATION TEST

DATALOG

log inter 1 8 channels 2

Year	Month	Day	Hour	Minute	Second	1/100 sec	Maximum: 1	2	3	4	5	6	7	8
92	11	3	16	57	54	40	-6.86238	75.7479	52.0392	75.51	76.37	0.013548	1.58093	-1.5822
92	11	3	16	57	58	8	-7.12438	75.7714	52.4334	75.6	76.41	0.013539	1.58097	-1.58215
92	11	3	16	58	1	70	-7.12493	75.774	52.6544	75.4	76.37	0.013504	1.58104	-1.58198
92	11	3	16	58	5	27	-6.41623	75.7804	52.8846	75.38	76.39	0.013503	1.5811	-1.58202
92	11	3	16	58	9	1	-7.57251	75.7746	52.391	75.58	76.37	0.013609	1.58099	-1.58211
92	11	3	16	58	18	56	-6.15423	75.7718	52.2815	75.56	76.42	0.013538	1.58104	-1.58218
92	11	3	16	58	22	13	-6.56548	75.7652	51.928	75.52	76.41	0.0135	1.58106	-1.58211
92	11	3	16	58	25	65	-6.41463	75.7737	52.3872	75.61	76.42	0.013537	1.58097	-1.58207
92	11	3	16	58	29	17	-6.67676	75.7762	52.278	75.74	76.41	0.013516	1.58103	-1.58204
92	11	3	16	58	32	68	-7.04924	75.783	51.98	75.83	76.42	0.013535	1.58095	-1.58204
92	11	3	16	58	36	20	-6.37881	75.7682	51.9879	75.81	76.37	0.013519	1.58098	-1.58217
92	11	3	16	58	39	66	-5.70733	75.7663	52.1393	75.7	76.42	0.013525	1.58111	-1.58204
92	11	3	16	58	43	17	-6.26671	75.7719	52.2339	75.87	76.42	0.013522	1.58108	-1.58208
92	11	3	16	58	46	69	-6.56412	75.7646	52.1851	75.9	76.44	0.013542	1.58098	-1.58211
92	11	3	16	58	50	20	-6.41473	75.7717	51.9261	75.7	76.46	0.013541	1.58102	-1.58205
92	11	3	16	58	53	72	-6.45237	75.7684	51.8482	75.29	76.39	0.013551	1.58102	-1.58204
92	11	3	16	58	57	23	-7.08684	75.7698	51.8651	75.27	76.41	0.013498	1.58099	-1.58211
92	11	3	16	59	0	69	-7.19798	75.7783	51.9272	75.22	76.41	0.013553	1.58106	-1.58203
92	11	3	16	59	4	21	-7.12359	75.7689	51.9759	75.2	76.44	0.013497	1.58105	-1.58212
92	11	3	16	59	7	67	-6.60235	75.7798	51.9651	75.22	76.42	0.013478	1.58111	-1.58205
92	11	3	16	59	11	24	-6.52737	75.7814	51.9801	75.18	76.41	0.013544	1.58101	-1.58214
92	11	3	16	59	14	75	-6.37791	75.7849	51.8646	74.97	76.46	0.01353	1.58106	-1.58206
92	11	3	16	59	18	21	-7.1993	75.7742	51.9339	75	76.41	0.013523	1.58099	-1.58214
92	11	3	16	59	21	73	-7.45997	75.7657	51.85	75.15	76.37	0.013496	1.58105	-1.58211
92	11	3	16	59	25	24	-5.7066	75.7713	51.8712	74.86	76.41	0.013545	1.58096	-1.58213
92	11	3	16	59	28	76	-8.42888	75.7706	51.9034	75.13	76.41	0.013544	1.58097	-1.58208
92	11	3	16	59	32	27	-7.87065	75.7707	51.8427	75.18	76.37	0.013498	1.58098	-1.58205
92	11	3	16	59	35	73	-6.71289	75.7731	51.9722	75.24	76.41	0.013539	1.58104	-1.58209
92	11	3	16	59	39	25	-5.89281	75.7778	51.981	75.34	76.44	0.013507	1.581	-1.58212
92	11	3	16	59	42	77	-5.8191	75.7825	51.8514	75.2	76.41	0.013573	1.581	-1.58211
92	11	3	16	59	46	28	-7.64765	75.7821	51.8649	75.22	76.37	0.013474	1.58096	-1.58213
92	11	3	16	59	49	80	-6.63926	75.7785	51.9263	75.33	76.48	0.013546	1.58107	-1.58206
92	11	3	16	59	53	31	-6.22918	75.7741	51.9207	75.42	76.42	0.013554	1.58103	-1.58209
92	11	3	16	59	56	77	-5.18404	75.7801	51.9568	75.87	76.44	0.013489	1.58108	-1.58202
92	11	3	17	0	0	34	-5.89289	75.7823	51.8716	75.49	76.44	0.01355	1.58096	-1.5821
92	11	3	17	0	3	80	-7.23693	75.7844	51.8488	75.09	76.41	0.013567	1.58097	-1.58209
92	11	3	17	0	7	32	-6.49051	75.7749	51.9818	75.16	76.39	0.013531	1.58094	-1.58214
92	11	3	17	0	10	83	-6.56553	75.7828	51.8888	75.15	76.42	0.013525	1.58103	-1.58202
92	11	3	17	0	14	29	-7.16257	75.7691	51.9612	75.27	76.32	0.013512	1.58104	-1.58214
92	11	3	17	0	17	81	-7.31191	75.7859	51.9625	75.24	76.41	0.013531	1.5811	-1.58205
92	11	3	17	0	21	32	-7.08686	75.7869	51.9834	75.2	76.41	0.013495	1.58106	-1.58209
92	11	3	17	0	24	84	-6.63995	75.775	51.9733	75.31	76.44	0.013548	1.58101	-1.58203
92	11	3	17	0	28	30	-7.42383	75.7985	51.9022	75.31	76.41	0.013501	1.58112	-1.58197
92	11	3	17	0	31	81	-6.04291	75.7769	51.9717	75.43	76.39	0.013478	1.58099	-1.58209
92	11	3	17	0	35	33	-6.49182	75.781	51.9473	75.61	76.39	0.013528	1.58101	-1.58219
92	11	3	17	0	38	79	-7.38764	75.7818	51.9114	75.6	76.35	0.013484	1.58099	-1.58215
92	11	3	17	0	42	30	-7.27505	75.785	51.9698	75.61	76.37	0.013534	1.581	-1.58218
92	11	3	17	0	45	82	-6.11793	75.7824	51.8518	75.61	76.42	0.013498	1.58103	-1.58218
92	11	3	17	0	49	28	-6.78997	75.7725	51.8775	75.24	76.46	0.013574	1.58095	-1.58215
92	11	3	17	0	52	80	-6.93942	75.7874	51.9141	75.25	76.37	0.013526	1.58094	-1.58217
92	11	3	17	0	56	31	-6.82748	75.7895	51.8489	75.31	76.42	0.013504	1.58103	-1.58205
92	11	3	17	0	59	77	-7.01173	75.7907	51.858	75.22	76.41	0.013511	1.58095	-1.58208
92	11	3	17	1	3	29	-7.16124	75.7889	51.9549	75.24	76.46	0.0135	1.58102	-1.58204
92	11	3	17	1	6	80	-7.87063	75.7979	51.901	75.13	76.44	0.013554	1.58105	-1.58205
92	11	3	17	1	10	26	-6.15488	75.7956	51.9744	74.91	76.39	0.013527	1.58111	-1.58199
92	11	3	17	1	13	78	-5.55716	75.7949	51.9471	75.33	76.46	0.013503	1.58113	-1.58197
92	11	3	17	1	17	29	-6.71412	75.7944	51.9494	75.38	76.44	0.013519	1.58105	-1.58208
92	11	3	17	1	20	81	-6.86379	75.7854	51.89	75.49	76.41	0.013507	1.58096	-1.58209
92	11	3	17	1	24	27	-7.72205	75.7977	51.9166	75.51	76.37	0.013486	1.58105	-1.58206
92	11	3	17	1	27	78	-7.57315	75.8032	51.9813	75.61	76.37	0.013484	1.58103	-1.58202
92	11	3	17	1	31	30	-7.23623	75.7916	51.9795	75.61	76.37	0.013495	1.581	-1.58209
92	11	3	17	1	34	76	-6.78936	75.7938	51.8368	75.69	76.39	0.013521	1.58113	-1.58195
92	11	3	17	1	38	27	-7.34809	75.7782	51.9102	75.63	76.37	0.013534	1.58088	-1.58233
92	11	3	17	1	42	89	-6.93743	75.811	51.9696	75.67	76.37	0.013557	1.58101	-1.58203
92	11	3	17	1	46	40	-6.26623	75.7995	51.9869	75.6	76.42	0.013546	1.58104	-1.58197
92	11	3	17	1	49	92	-6.49047	75.8014	51.9567	75.47	76.42	0.013538	1.58106	-1.58201

92	11	3	17	1	53	38	-7.98181	75.7979	51.9792	75.58	76.39	0.013563	1.58101	-1.5821
92	11	3	17	1	56	89	-6.93873	75.7962	51.9316	75.52	76.37	0.013518	1.58098	-1.5821
92	11	3	17	2	0	41	-6.63991	75.8006	51.964	75.76	76.39	0.013485	1.58099	-1.58205
92	11	3	17	2	3	92	-7.0131	75.7947	51.9167	75.72	76.37	0.013571	1.58105	-1.58214
92	11	3	17	2	7	38	-8.54141	75.8041	51.9722	75.6	76.35	0.013575	1.58103	-1.58191
92	11	3	17	2	10	90	-7.08827	75.7999	51.8519	75.58	76.37	0.013517	1.58111	-1.58203
92	11	3	17	2	14	41	-6.11724	75.8031	51.9849	75.78	76.42	0.013551	1.58104	-1.58197
92	11	3	17	2	17	93	-6.45304	75.8014	51.9808	75.94	76.41	0.013516	1.58099	-1.58217
92	11	3	17	2	21	39	-6.93805	75.8082	51.8388	75.76	76.44	0.013565	1.58102	-1.58202
92	11	3	17	2	24	91	-7.23699	75.7915	51.9032	75.6	76.39	0.013551	1.58106	-1.58207
92	11	3	17	2	28	42	-7.8701	75.8023	51.9014	75.54	76.41	0.013516	1.58112	-1.58192
92	11	3	17	2	31	88	-7.19933	75.7992	51.8922	75.58	76.41	0.013563	1.58102	-1.58208
92	11	3	17	2	35	40	-7.34878	75.8051	51.9536	75.58	76.39	0.013569	1.58099	-1.58212
92	11	3	17	2	38	91	-6.93807	75.8092	51.9229	75.47	76.41	0.013529	1.58107	-1.58202
92	11	3	17	2	42	43	-6.71375	75.8088	51.9022	75.65	76.42	0.013518	1.58099	-1.582
92	11	3	17	2	45	94	-7.31053	75.7966	51.884	75.69	76.42	0.013524	1.58096	-1.58217
92	11	3	17	2	49	40	-7.90756	75.8084	51.9734	75.69	76.39	0.01352	1.58102	-1.58204
92	11	3	17	2	52	92	-8.2433	75.7934	51.864	75.42	76.33	0.013581	1.58092	-1.58216
92	11	3	17	2	56	38	-7.49806	75.8061	51.9714	75.4	76.42	0.01355	1.58102	-1.58217
92	11	3	17	2	59	95	-7.04865	75.8056	51.9852	75.58	76.37	0.013567	1.58104	-1.58208
92	11	3	17	3	3	41	-6.975	75.8024	51.982	75.67	76.42	0.013528	1.58106	-1.58207
92	11	3	17	3	6	92	-7.94437	75.8058	51.8947	75.33	76.37	0.013545	1.58094	-1.58218
92	11	3	17	3	10	38	-7.12307	75.8113	51.9698	75.6	76.41	0.013508	1.58106	-1.58202
92	11	3	17	3	13	90	-6.75046	75.8109	51.9604	75.43	76.42	0.013574	1.58091	-1.58211
92	11	3	17	3	17	41	-6.78863	75.8046	51.862	75.13	76.41	0.013519	1.58098	-1.58216
92	11	3	17	3	20	93	-7.53508	75.8157	51.8681	75.13	76.39	0.013556	1.58096	-1.58207
92	11	3	17	3	24	39	-7.72196	75.81	51.9613	75.24	76.39	0.013541	1.58096	-1.58206
92	11	3	17	3	27	90	-7.08681	75.8032	51.9472	75.42	76.42	0.013559	1.581	-1.58215
92	11	3	17	3	31	42	-6.22915	75.7983	51.9843	75.51	76.42	0.013564	1.58094	-1.58214
92	11	3	17	3	34	94	-7.05001	75.8072	51.8999	75.63	76.44	0.013546	1.58099	-1.58216
92	11	3	17	3	38	40	-7.34876	75.8014	51.9096	75.74	76.42	0.013544	1.58093	-1.58207
92	11	3	17	3	41	91	-6.82554	75.7976	51.9074	75.49	76.39	0.013569	1.58097	-1.58223
92	11	3	17	3	45	43	-6.378	75.8051	51.9748	75.63	76.44	0.013574	1.58103	-1.58212
92	11	3	17	3	48	94	-7.72338	75.8006	51.8868	75.79	76.33	0.013503	1.58106	-1.58219
92	11	3	17	3	52	40	-7.38567	75.8187	51.9546	75.67	76.42	0.013513	1.58104	-1.58199
92	11	3	17	3	55	92	-7.64635	75.8102	51.849	75.72	76.42	0.013539	1.58109	-1.58207
92	11	3	17	3	59	43	-7.75879	75.817	51.8658	75.79	76.37	0.013512	1.58097	-1.58203
92	11	3	17	4	2	89	-6.9382	75.8139	51.8679	75.88	76.39	0.013523	1.58103	-1.582
92	11	3	17	4	6	41	-7.94582	75.8063	51.9098	75.94	76.35	0.013491	1.58102	-1.58207
92	11	3	17	4	9	92	-7.83331	75.8153	51.8825	76.17	76.35	0.013584	1.58106	-1.58211
92	11	3	17	4	13	44	-7.57313	75.8223	51.9104	76.26	76.41	0.013695	1.58096	-1.58205
92	11	3	17	4	16	95	-6.67797	75.8178	51.8282	76.19	76.37	0.01369	1.58089	-1.58215
92	11	3	17	4	20	41	65.1349	75.8148	51.9836	75.72	76.42	0.013556	1.58092	-1.5821
92	11	3	17	4	23	93	-14.1647	75.8242	51.9813	75.52	76.48	0.013525	1.58101	-1.58211
92	11	3	17	4	27	44	-77.1184	75.8257	51.9045	75.69	76.44	0.013534	1.58102	-1.58203
92	11	3	17	4	30	96	32.543	75.8241	51.9761	75.63	76.41	0.013523	1.58107	-1.58202
92	11	3	17	4	34	47	-46.55	75.8176	51.9396	75.38	76.44	0.013544	1.581	-1.58211
92	11	3	17	4	37	99	-8.05553	75.8334	51.9122	75.74	76.44	0.013582	1.58108	-1.58199
92	11	3	17	4	41	45	-54.2618	75.8305	51.8363	75.9	76.44	0.013566	1.58108	-1.58202
92	11	3	17	4	44	97	-0.97008	75.8212	51.8817	76.03	76.42	0.013493	1.58105	-1.58205
92	11	3	17	4	48	43	28.5571	75.8304	51.9543	75.78	76.42	0.013538	1.5809	-1.58211
92	11	3	17	4	52	0	-14.0168	75.8285	51.8808	75.65	76.41	0.013523	1.58099	-1.58211
92	11	3	17	4	55	46	-7.53371	75.8299	51.8688	75.63	76.46	0.013512	1.58108	-1.58198
92	11	3	17	4	58	97	11.5855	75.8293	51.8735	75.61	76.46	0.013534	1.58097	-1.58207
92	11	3	17	5	2	49	-65.8346	75.8303	51.9313	75.72	76.48	0.013558	1.58103	-1.58203
92	11	3	17	5	5	95	-80.7814	75.8413	51.91	75.81	76.46	0.013516	1.58107	-1.58194
92	11	3	17	5	9	46	-93.9557	75.836	51.8583	75.85	76.41	0.013533	1.58099	-1.58213
92	11	3	17	5	12	98	-98.4244	75.8388	51.9649	75.97	76.42	0.013496	1.58101	-1.58214
92	11	3	17	5	16	49	18.8877	75.8348	51.8386	75.81	76.39	0.013531	1.581	-1.58214
92	11	3	17	5	20	1	17.876	75.8401	51.8838	75.43	76.46	0.013511	1.58102	-1.58208
92	11	3	17	5	23	47	-29.9243	75.8385	51.9615	75.42	76.37	0.013493	1.58097	-1.58218
92	11	3	17	5	26	98	33.0996	75.8391	51.8921	75.51	76.46	0.013552	1.58087	-1.58218
92	11	3	17	5	31	54	10.0507	75.8386	51.9841	75.29	76.44	0.013528	1.58107	-1.58219
92	11	3	17	5	35	11	45.3734	75.8492	51.9095	75.15	76.42	0.013495	1.58106	-1.582
92	11	3	17	5	38	57	28.3309	75.8461	51.864	75.04	76.44	0.013536	1.581	-1.58207
92	11	3	17	5	42	9	-50.7288	75.8475	51.9594	75.11	76.48	0.013507	1.58115	-1.58198
92	11	3	17	5	45	60	-2.68714	75.8297	51.8764	75.09	76.41	0.013563	1.58095	-1.58208
92	11	3	17	5	49	12	-31.5132	75.8334	51.9483	75.45	76.46	0.013567	1.58094	-1.58208
92	11	3	17	5	52	58	-17.0273	75.8454	51.8721	75.67	76.5	0.013582	1.58101	-1.58209
92	11	3	17	5	56	9	7.17362	75.8389	51.9533	75.63	76.41	0.013508	1.58106	-1.58213

92	11	3	17	5	59	61	40.3701	75.8397	51.8523	75.38	76.42	0.013518	1.58098	-1.5821
92	11	3	17	6	3	12	11.7718	75.8448	51.8729	75.4	76.42	0.013516	1.58118	-1.58196
92	11	3	17	6	6	58	23.4218	75.8509	51.9435	75.58	76.39	0.013548	1.58113	-1.58205
92	11	3	17	6	10	10	-36.4844	75.8451	51.9802	75.58	76.42	0.013583	1.58101	-1.58215
92	11	3	17	6	13	61	-25.432	75.8497	51.8313	75.58	76.39	0.013517	1.581	-1.58215
92	11	3	17	6	17	13	-17.848	75.8362	51.846	75.56	76.39	0.013558	1.58103	-1.58211
92	11	3	17	6	20	59	-9.24667	75.8419	51.8997	75.34	76.48	0.013555	1.58088	-1.58214
92	11	3	17	6	24	11	-39.5165	75.8482	51.8479	75.29	76.48	0.013507	1.58101	-1.58207
92	11	3	17	6	27	62	-36.4781	75.8459	51.8651	75.29	76.44	0.01353	1.58101	-1.5821
92	11	3	17	6	31	14	67.8692	75.8382	51.8542	75.65	76.44	0.013572	1.5809	-1.58212
92	11	3	17	6	34	60	-4.58853	75.8499	51.8915	75.45	76.48	0.013563	1.58114	-1.58203
92	11	3	17	6	38	11	17.6077	75.8473	51.8341	75.47	76.48	0.013526	1.58101	-1.58206
92	11	3	17	6	41	63	-85.9693	75.849	51.9836	75.58	76.44	0.013541	1.58099	-1.58206
92	11	3	17	6	45	14	-70.2158	75.8464	51.9828	75.83	76.42	0.013517	1.58101	-1.58203
92	11	3	17	6	48	66	-5.5212	75.8505	51.9816	75.88	76.44	0.013514	1.58106	-1.58203
92	11	3	17	6	52	12	-62.5697	75.8505	51.9493	75.74	76.44	0.013525	1.58104	-1.58188
92	11	3	17	6	55	63	-25.0917	75.8456	51.8576	75.94	76.48	0.013564	1.58104	-1.58206
92	11	3	17	6	59	15	-10.4409	75.8485	51.8552	75.9	76.41	0.01352	1.58103	-1.58198
92	11	3	17	7	2	61	7.4336	75.8622	51.8594	75.69	76.42	0.013505	1.58107	-1.58198
92	11	3	17	7	6	18	10.762	75.8452	51.969	75.61	76.46	0.013535	1.58105	-1.58206
92	11	3	17	7	9	64	-22.4929	75.8514	51.9043	75.45	76.42	0.013552	1.58097	-1.58203
92	11	3	17	7	13	15	-86.5975	75.8638	51.9267	75.51	76.46	0.013501	1.58101	-1.58208
92	11	3	17	7	16	61	-76.377	75.8486	51.8489	75.74	76.46	0.013518	1.581	-1.58212
92	11	3	17	7	20	13	-26.6904	75.8579	51.8992	75.74	76.44	0.013491	1.58094	-1.58208
92	11	3	17	7	23	64	60.4478	75.8495	51.8886	75.72	76.42	0.013532	1.58105	-1.58208
92	11	3	17	7	27	16	-35.0271	75.8489	51.8523	75.56	76.48	0.013542	1.58088	-1.58215
92	11	3	17	7	30	68	-37.5107	75.8723	51.8861	75.76	76.5	0.013539	1.58108	-1.582
92	11	3	17	7	34	14	46.3826	75.8489	51.8415	75.85	76.44	0.013497	1.58095	-1.58221
92	11	3	17	7	37	65	-66.2092	75.8567	51.9818	75.79	76.41	0.013487	1.58105	-1.58203
92	11	3	17	7	41	17	-49.6118	75.8584	51.9935	75.94	76.46	0.013497	1.58105	-1.58208
92	11	3	17	7	44	68	-51.0842	75.8621	51.9076	76.08	76.46	0.013531	1.58107	-1.58196
92	11	3	17	7	48	20	-2.46276	75.8521	51.8505	75.9	76.46	0.013482	1.58103	-1.58212
92	11	3	17	7	51	66	27.2172	75.8661	51.9909	75.63	76.39	0.013488	1.58108	-1.58211
92	11	3	17	7	55	17	-5.07357	75.858	51.9954	75.42	76.42	0.013481	1.58113	-1.58192
92	11	3	17	7	58	69	14.1667	75.871	51.9126	75.25	76.39	0.013466	1.58104	-1.58216
92	11	3	17	8	2	20	-43.0313	75.8631	51.8615	75.49	76.46	0.013496	1.58108	-1.58209
92	11	3	17	8	5	66	-70.775	75.8574	51.9767	75.61	76.42	0.013537	1.58102	-1.58209
92	11	3	17	8	9	18	-43.9585	75.8629	51.9837	75.85	76.44	0.013473	1.5811	-1.58206
92	11	3	17	8	12	69	-27.8762	75.8604	51.9475	75.9	76.46	0.013485	1.58095	-1.58211
92	11	3	17	8	16	21	-67.1018	75.8654	51.9775	75.96	76.44	0.013525	1.58103	-1.58203
92	11	3	17	8	19	67	-105.573	75.8572	51.8266	76.1	76.46	0.013553	1.58093	-1.58223
92	11	3	17	8	23	18	-88.1878	75.8622	51.939	76.17	76.44	0.013551	1.58097	-1.58203
92	11	3	17	8	26	70	-14.7226	75.8724	51.9833	76.17	76.44	0.013564	1.5811	-1.582
92	11	3	17	8	30	21	-84.4877	75.8719	51.9671	76.19	76.44	0.013496	1.58104	-1.58214
92	11	3	17	8	33	68	42.1629	75.8658	51.8582	75.9	76.44	0.013535	1.58102	-1.58209
92	11	3	17	8	37	19	-97.4301	75.8661	51.8454	75.9	76.41	0.013512	1.5809	-1.58206
92	11	3	17	8	40	71	-95.9077	75.8654	51.9587	76.05	76.44	0.013538	1.58104	-1.58213
92	11	3	17	8	44	22	-2.79836	75.8702	51.9808	76.06	76.46	0.013498	1.58105	-1.58195
92	11	3	17	8	47	68	34.3677	75.8682	51.8472	75.9	76.48	0.013543	1.58098	-1.58209
92	11	3	17	8	51	20	-51.7914	75.8618	51.8405	75.81	76.46	0.013525	1.58095	-1.58199
92	11	3	17	8	54	71	31.5368	75.8617	51.9181	75.72	76.48	0.013523	1.58102	-1.58195
92	11	3	17	8	58	23	-57.3688	75.8716	51.942	75.69	76.48	0.013533	1.58104	-1.58194
92	11	3	17	9	1	74	1.45576	75.8582	51.9113	75.54	76.48	0.013536	1.58104	-1.58211
92	11	3	17	9	5	26	62.8061	75.8605	51.8756	75.42	76.46	0.013526	1.58098	-1.58218
92	11	3	17	9	8	72	58.3102	75.8586	51.9536	75.4	76.5	0.013526	1.58106	-1.58211
92	11	3	17	9	12	23	9.00315	75.8579	51.8525	75.36	76.44	0.013534	1.58096	-1.58212
92	11	3	17	9	15	69	25.2455	75.8628	51.9872	75.22	76.42	0.013482	1.58111	-1.582
92	11	3	17	9	20	31	44.1773	75.8567	51.8891	75.16	76.46	0.013521	1.58102	-1.58202
92	11	3	17	9	23	82	23.0878	75.8517	51.9118	75.16	76.39	0.013464	1.58103	-1.58215
92	11	3	17	9	27	34	-3.95472	75.8548	51.9864	75.33	76.44	0.013462	1.58112	-1.58209
92	11	3	17	9	30	85	-15.9142	75.869	51.8563	75.58	76.42	0.01347	1.58114	-1.58202
92	11	3	17	9	34	31	37.6856	75.8624	51.8522	75.58	76.39	0.013482	1.58098	-1.58216
92	11	3	17	9	37	83	-22.7857	75.8594	51.9127	75.42	76.44	0.013545	1.58097	-1.58201
92	11	3	17	9	41	34	-9.65828	75.8551	51.9756	75.56	76.46	0.013498	1.58108	-1.58223
92	11	3	17	9	44	86	22.9708	75.8622	51.8496	75.45	76.44	0.013472	1.58095	-1.58217
92	11	3	17	9	48	37	17.7988	75.8786	51.9952	75.31	76.48	0.013511	1.5811	-1.58183
92	11	3	17	9	51	83	22.4109	75.8606	51.9135	75.16	76.46	0.013534	1.58109	-1.582
92	11	3	17	9	55	35	12.7442	75.8623	51.8488	75.18	76.42	0.01348	1.58108	-1.58207
92	11	3	17	9	58	86	40.5206	75.8456	51.8439	75.04	76.46	0.013542	1.58095	-1.58221
92	11	3	17	10	2	38	31.7593	75.8596	51.9596	75.04	76.42	0.013517	1.58097	-1.5821

92	11	3	17	10	5	84	57.7504	75.8537	51.8511	75.15	76.44	0.013538	1.58095	-1.58213
92	11	3	17	10	9	36	-5.63303	75.8631	51.89	75.27	76.41	0.013475	1.58105	-1.58209
92	11	3	17	10	12	87	15.7409	75.8588	51.9508	75.11	76.44	0.013495	1.58096	-1.58199
92	11	3	17	10	16	39	-6.56569	75.8793	51.9752	75.02	76.46	0.013484	1.58109	-1.58204
92	11	3	17	10	19	85	74.0621	75.8713	51.9044	75.06	76.48	0.013534	1.58098	-1.58201
92	11	3	17	10	23	36	100.053	75.8652	51.8668	74.86	76.5	0.013462	1.58102	-1.58205
92	11	3	17	10	26	88	40.4837	75.876	51.9144	74.86	76.46	0.013515	1.58101	-1.58211
92	11	3	17	10	30	39	-14.9804	75.8679	51.9209	74.91	76.46	0.013536	1.58105	-1.58201
92	11	3	17	10	33	85	-10.2909	75.8628	51.8631	75.29	76.46	0.013467	1.5812	-1.58187
92	11	3	17	10	37	42	44.141	75.8751	51.9369	75.27	76.44	0.013499	1.58103	-1.58196
92	11	3	17	10	40	94	-53.4443	75.8567	51.935	75.38	76.5	0.013503	1.581	-1.58208
92	11	3	17	10	44	45	-21.7908	75.8698	51.8597	75.34	76.44	0.013467	1.581	-1.582
92	11	3	17	10	47	91	-19.0725	75.8618	51.934	75.56	76.48	0.013528	1.58089	-1.58214
92	11	3	17	10	51	43	37.3879	75.8502	51.8454	75.43	76.42	0.01353	1.581	-1.58207
92	11	3	17	10	54	94	-7.83049	75.8582	51.9692	75.42	76.46	0.013499	1.58093	-1.58215
92	11	3	17	10	58	46	13.7928	75.8712	51.85	75.4	76.44	0.013463	1.58112	-1.58207
92	11	3	17	11	1	92	11.3223	75.8684	51.9332	75.31	76.5	0.013512	1.58104	-1.58204
92	11	3	17	11	5	43	-7.98044	75.8704	51.847	75.42	76.48	0.013506	1.58101	-1.58203
92	11	3	17	11	8	95	-36.9596	75.8529	51.8428	75.42	76.46	0.013457	1.58094	-1.58221
92	11	3	17	11	12	46	-16.095	75.8536	51.8545	75.36	76.46	0.013562	1.58097	-1.58211
92	11	3	17	11	15	98	288.077	75.872	51.9278	75.54	76.42	0.013553	1.58103	-1.58213
92	11	3	17	11	19	44	-6.82369	75.8914	51.9559	75.72	76.48	0.013746	1.58117	-1.58175
92	11	3	17	11	24	99	-7.23545	75.8732	51.8615	75.78	76.44	0.013555	1.58102	-1.582
92	11	3	17	11	28	56	-7.19877	75.862	51.9392	75.58	76.46	0.013605	1.58101	-1.58224
92	11	3	17	11	32	18	-6.45234	75.8699	51.8444	75.97	76.48	0.01361	1.58107	-1.58212
92	11	3	17	11	35	81	-7.53367	75.8622	51.8633	75.87	76.5	0.013582	1.58102	-1.58211
92	11	3	17	11	39	38	-6.56488	75.865	51.9636	75.54	76.51	0.013545	1.58104	-1.58205
92	11	3	17	11	43	0	-7.60883	75.8575	51.8462	75.69	76.46	0.013569	1.58102	-1.58219
92	11	3	17	11	46	57	-7.04944	75.8535	51.8711	75.7	76.41	0.013533	1.58104	-1.58209
92	11	3	17	11	50	20	-7.19884	75.853	51.8805	75.72	76.5	0.013564	1.581	-1.58207
92	11	3	17	11	53	82	-7.04927	75.8463	51.8932	76.03	76.5	0.013606	1.58103	-1.58214
92	11	3	17	11	57	45	-6.45304	75.8434	51.8619	76.41	76.48	0.013596	1.58108	-1.58196
92	11	3	17	12	1	2	-7.27303	75.8381	51.8771	76.17	76.5	0.0136	1.58098	-1.58209
92	11	3	17	12	4	64	-7.46007	75.8446	51.9892	76.55	76.44	0.013538	1.581	-1.58219
92	11	3	17	12	8	21	-6.60114	75.8343	51.925	76.73	76.44	0.013568	1.58098	-1.58206
92	11	3	17	12	11	84	-7.7589	75.8459	51.8844	76.64	76.46	0.013568	1.58113	-1.58198
92	11	3	17	12	15	52	-6.86108	75.8239	51.8812	76.75	76.5	0.013547	1.58094	-0.00981
92	11	3	17	12	19	20	-6.18974	75.8236	51.9735	75.99	76.5	0.013565	1.581	-0.00873
92	11	3	17	12	22	82	-7.57005	75.8349	52.3766	75.79	76.46	0.01354	1.58101	-0.00845
92	11	3	17	12	26	56	-6.63719	75.8297	52.8627	76.19	76.5	0.013549	1.5811	-0.00981
92	11	3	17	12	30	18	-5.77965	75.8266	52.9241	75.76	76.55	0.013576	1.58106	-0.00875
92	11	3	17	12	33	92	-5.89025	75.8226	52.9289	76.3	76.5	0.013599	1.58099	-0.00981
92	11	3	17	12	37	54	-6.67331	75.8317	52.9871	76.14	76.46	0.013546	1.58112	-0.00837
92	11	3	17	12	41	28	-6.37606	75.823	52.8365	75.38	76.46	0.013538	1.58094	-0.00981
92	11	3	17	12	44	96	-6.45121	75.8227	52.9056	74.43	76.42	0.013582	1.58104	-0.00877
92	11	3	17	12	48	58	-6.78675	75.8205	52.9757	74.73	76.48	0.013581	1.58103	-0.00871
92	11	3	17	12	52	26	-6.63747	75.8112	52.9203	75.78	76.39	0.01357	1.58093	-0.00109
92	11	3	17	12	56	0	-6.78805	75.8177	52.9763	75.83	76.44	0.013563	1.58097	-0.00981
92	11	3	17	12	59	62	-6.63608	75.8247	52.9192	75.65	76.44	0.013541	1.58089	-0.00749
92	11	3	17	13	3	25	-7.49685	75.8344	52.9438	75.69	76.42	0.013778	1.58077	-1.58211
92	11	3	17	13	6	82	-9.06333	75.8363	52.8413	74.77	76.39	0.013689	1.58083	-1.58219
92	11	3	17	13	10	44	1200.97	75.8187	52.8949	74.61	76.46	0.013526	1.58093	-1.58218
92	11	3	17	13	15	22	1093.09	75.8212	52.8411	75.33	76.44	0.013424	-0.00981	-1.58235
92	11	3	17	13	18	85	1096.57	75.849	52.8373	75.49	76.44	0.013832	1.58097	-1.58213
92	11	3	17	13	22	47	1114.08	75.8535	52.9496	75.16	76.5	0.013781	1.58097	-1.58206
92	11	3	17	13	26	4	1103.98	75.8461	52.9696	75.24	76.46	0.013588	1.58094	-1.58206
92	11	3	17	13	29	67	1155.23	75.8353	52.9449	74.8	76.48	0.01356	1.58086	-1.58217
92	11	3	17	13	33	29	1099.5	75.8481	52.8405	74.77	76.46	0.013569	1.58099	-1.58199
92	11	3	17	13	36	86	1117.55	75.8594	52.9192	74.46	76.48	0.013564	1.58108	-1.58193
92	11	3	17	13	40	49	1177.39	75.8494	52.9785	73.9	76.51	0.013582	1.58098	-1.58209
92	11	3	17	13	44	6	1142.17	75.8529	52.8795	73.54	76.44	0.013508	1.581	-1.58206
92	11	3	17	13	47	68	1091.8	75.8484	52.9613	73.58	76.44	0.013527	1.58091	-1.58217
92	11	3	17	13	51	31	1113.09	75.8645	52.9471	73.47	76.46	0.01348	1.58104	-1.58206
92	11	3	17	13	54	93	1033.79	75.8698	52.8683	73.35	76.48	0.013539	1.58102	-1.58209
92	11	3	17	13	58	50	1046.42	75.8926	52.8487	73.51	76.46	0.013576	1.581	-1.58206
92	11	3	17	14	2	13	1006.86	75.8696	52.8992	73.4	76.53	0.013547	1.58103	-1.58196
92	11	3	17	14	5	70	997.189	75.8699	52.8455	73.67	76.42	0.01348	1.58106	-1.58205
92	11	3	17	14	9	32	1056.89	75.8731	52.9717	73.17	76.51	0.0135	1.58102	-1.58208
92	11	3	17	14	12	89	967.724	75.8806	52.8718	73.04	76.48	0.013756	1.58106	-1.58207
92	11	3	17	14	16	52	1026.18	75.8803	52.8269	73.06	76.46	0.013645	1.58093	-1.58203

92	11	3	17	14	20	9	958.76	75.8754	52.897	73.29	76.5	0.013581	1.58094	-1.58214
92	11	3	17	14	23	72	1017.45	75.8749	52.8313	73.9	76.53	0.013585	1.58095	-1.5822
92	11	3	17	14	27	29	953.298	75.8808	52.9226	73.13	76.44	0.013756	1.58117	-1.58197
92	11	3	17	14	30	97	932.056	75.8845	52.8443	73.76	76.46	0.013704	1.58094	-1.58207
92	11	3	17	14	34	54	871.074	75.886	52.9427	73.92	76.46	0.013719	1.58103	-1.58211
92	11	3	17	14	38	16	924.812	75.8839	52.8444	73.67	76.46	0.013695	1.58093	-1.58207
92	11	3	17	14	41	73	875.928	75.897	52.9091	73.76	76.48	0.013745	1.58113	-1.58198
92	11	3	17	14	45	36	907.093	75.887	52.8639	74.1	76.42	0.013694	1.581	-1.58212
92	11	3	17	14	48	98	869.359	75.8916	52.8993	73.56	76.5	0.013586	1.58108	-1.58203
92	11	3	17	14	52	61	843.367	75.888	52.8425	73.56	76.42	0.013465	-0.00973	-1.58203
92	11	3	17	14	56	29	879.296	75.8957	52.9221	73.02	76.5	0.013459	-0.00972	-1.58207
92	11	3	17	14	59	91	776.479	75.8821	52.8566	73.67	76.5	0.013494	1.58104	-1.5821
92	11	3	17	15	3	48	811.351	75.885	52.9595	73.24	76.48	0.013523	1.58106	-1.58204
92	11	3	17	15	7	11	765.004	75.8819	52.8664	73.56	76.53	0.013539	1.58093	-1.58205
92	11	3	17	15	10	68	808.895	75.8849	52.8563	72.95	76.5	0.013493	1.58103	-1.58205
92	11	3	17	15	14	30	717.22	75.879	52.8629	73.99	76.53	0.013501	1.58108	-1.58207
92	11	3	17	15	17	93	686.14	75.8763	52.845	74.35	76.46	0.013536	1.58097	-1.58218
92	11	3	17	15	21	50	802.897	75.8884	52.9436	73.92	76.53	0.013529	1.58106	-1.58191
92	11	3	17	15	25	12	736.979	75.8917	52.8497	73.53	76.53	0.013545	1.58099	-1.58194
92	11	3	17	15	28	69	784.036	75.8877	52.8408	73.26	76.51	0.013537	1.58096	-1.58208
92	11	3	17	15	32	32	716.381	75.8851	52.9362	73.47	76.53	0.013551	1.58097	-1.58209
92	11	3	17	15	35	89	754.806	75.879	52.8432	73.74	76.5	0.013502	1.58097	-1.58209
92	11	3	17	15	39	51	665.633	75.881	52.8756	73.38	76.53	0.013562	1.58107	-1.58209
92	11	3	17	15	43	8	690.193	75.891	52.8424	73.24	76.42	0.013794	1.58093	-1.58214
92	11	3	17	15	46	76	682.497	75.8904	52.9839	72.95	76.53	0.013386	-0.00868	-1.58203
92	11	3	17	15	50	44	687.154	75.8935	52.8448	73.78	76.42	0.013416	-0.00788	-1.58215
92	11	3	17	15	54	7	640	75.8821	52.8456	73.51	76.48	0.013506	1.58111	-1.58204
92	11	3	17	15	57	64	569.3	75.8826	52.8604	73.83	76.51	0.013544	1.58098	-1.58211
92	11	3	17	16	1	26	635.092	75.8714	52.8695	73.65	76.51	0.013654	1.58104	-1.58216
92	11	3	17	16	4	83	523.102	75.9025	52.8879	73.98	76.53	0.013724	1.58102	-1.58192
92	11	3	17	16	8	46	541.51	75.9033	52.9837	74.32	76.51	0.013595	1.58102	-1.58207
92	11	3	17	16	12	3	545.771	75.8919	52.8683	74.32	76.51	0.013492	1.58107	-1.58207
92	11	3	17	16	15	65	582.498	75.8901	52.8542	73.9	76.51	0.01353	1.58108	-1.58195
92	11	3	17	16	19	22	519.567	75.8769	52.8816	73.63	76.51	0.013533	1.581	-1.58218
92	11	3	17	16	22	85	515.648	75.8832	52.8328	73.53	76.55	0.013556	1.58101	-1.58208
92	11	3	17	16	26	47	512.625	75.8846	52.9708	73.35	76.5	0.013569	1.58088	-1.58207
92	11	3	17	16	30	4	460.148	75.8963	52.9673	73.65	76.51	0.013548	1.58109	-1.58191
92	11	3	17	16	33	67	568.092	75.8971	52.8505	73.89	76.55	0.013775	1.58095	-1.58208
92	11	3	17	16	37	35	561.612	75.899	52.9694	73.53	76.53	0.013364	-0.00981	-1.58225
92	11	3	17	16	41	3	551.344	75.893	52.9581	72.9	76.44	0.013473	-0.00973	-1.58209
92	11	3	17	16	44	65	375.184	75.9052	52.8726	73.6	76.53	0.013604	1.58094	-1.58203
92	11	3	17	16	48	22	465.503	75.8965	52.9696	74.16	76.51	0.013513	1.58092	-1.58215
92	11	3	17	16	51	85	476.435	75.8853	52.9115	73.81	76.51	0.013479	1.58099	-1.5821
92	11	3	17	16	55	42	478.718	75.8944	52.9908	73.54	76.5	0.013488	1.5811	-1.58203
92	11	3	17	16	59	4	423.127	75.8929	52.932	73.47	76.53	0.013566	1.581	-1.58202
92	11	3	17	17	2	61	403.649	75.9001	52.8444	73.63	76.5	0.013483	1.58111	-1.582
92	11	3	17	17	6	24	434.822	75.89	52.8409	73.71	76.55	0.013519	1.58106	-1.58205
92	11	3	17	17	10	91	458.521	75.9003	52.9343	73.06	76.5	0.013526	1.581	-1.58209
92	11	3	17	17	14	53	368.131	75.891	52.9621	72.97	76.53	0.013558	1.58101	-1.58216
92	11	3	17	17	18	16	381.453	75.8873	52.9126	73.26	76.53	0.013494	1.58097	-1.58222
92	11	3	17	17	21	73	392.542	75.9014	52.8485	73.42	76.53	0.013647	1.58102	-1.58204
92	11	3	17	17	25	35	323.557	75.9044	52.9412	74.07	76.48	0.013688	1.58101	-1.58207
92	11	3	17	17	28	98	291.502	75.9154	52.8621	74.3	76.51	0.01375	1.58107	-1.58196
92	11	3	17	17	32	55	325.851	75.8866	52.8664	73.89	76.46	0.013741	1.58088	-1.58217
92	11	3	17	17	36	17	341.789	75.8989	52.8668	74.1	76.5	0.013708	1.58107	-1.58204
92	11	3	17	17	39	74	310.367	75.9117	52.8662	73.76	76.55	0.013783	1.58099	-1.582
92	11	3	17	17	43	37	294.233	75.9084	52.9638	73.85	76.53	0.01374	1.58105	-1.58199
92	11	3	17	17	46	99	257.624	75.9142	52.8851	74.21	76.51	0.013767	1.58103	-1.58202
92	11	3	17	17	50	56	210.973	75.8999	52.8278	74.37	76.48	0.013741	1.581	-1.58207
92	11	3	17	17	54	19	229.042	75.9018	52.8881	74.52	76.46	0.01373	1.58099	-1.58218
92	11	3	17	17	57	76	308.448	75.9124	52.8354	74.37	76.53	0.013754	1.58103	-1.58203
92	11	3	17	18	1	38	234.68	75.9032	52.9206	73.87	76.53	0.013578	1.58106	-1.58192
92	11	3	17	18	5	1	238.186	75.9081	52.8939	73.89	76.44	0.013546	1.58097	-1.582
92	11	3	17	18	8	58	244.903	75.9118	52.8682	73.94	76.51	0.013587	1.58097	-1.58203
92	11	3	17	18	12	21	227.349	75.9001	52.8375	73.99	76.51	0.013561	1.58096	-1.58208
92	11	3	17	18	15	78	205.372	75.9031	52.8855	74.21	76.51	0.013517	1.58099	-1.58203
92	11	3	17	18	19	46	257.222	75.9075	52.8431	73.89	76.41	0.013389	-0.00973	-1.58197
92	11	3	17	18	23	14	209.171	75.9125	52.8365	73.99	76.5	0.013373	-0.00973	-1.58205
92	11	3	17	18	26	71	216.152	75.9202	52.8811	74.05	76.5	0.013719	1.58112	-1.58195
92	11	3	17	18	30	33	270.721	75.9052	52.9726	74.34	76.53	0.013533	1.5809	-1.58212

92	11	3	17	18	33	96	244.352	75.9042	52.8837	74.1	76.48	0.01353	1.58097	-1.58218
92	11	3	17	18	37	53	159.668	75.9071	52.8372	74.01	76.48	0.013525	1.58094	-1.58213
92	11	3	17	18	41	15	180.957	75.9128	52.9072	74.14	76.53	0.013508	1.58113	-1.5819
92	11	3	17	18	44	72	229.717	75.9013	52.9678	74.1	76.53	0.01356	1.58093	-1.58221
92	11	3	17	18	48	35	208.792	75.9174	52.8762	73.71	76.51	0.013546	1.581	-1.58196
92	11	3	17	18	51	97	116.694	75.9097	52.9802	73.63	76.5	0.013503	1.58104	-1.58209
92	11	3	17	18	55	54	129.079	75.9234	52.9339	73.87	76.57	0.013761	1.58107	-1.58189
92	11	3	17	18	59	17	131.059	75.9127	52.9719	73.74	76.51	0.013676	1.58101	-1.58194
92	11	3	17	19	2	74	190.599	75.916	52.9703	73.54	76.51	0.013687	1.581	-1.58194
92	11	3	17	19	6	36	128.803	75.9305	52.9104	73.56	76.55	0.013767	1.581	-1.58207
92	11	3	17	19	9	93	70.1882	75.9356	52.9773	74.12	76.57	0.013741	1.58112	-1.58196
92	11	3	17	19	13	56	127.402	75.9354	52.8594	74.25	76.57	0.013759	1.58102	-1.58203
92	11	3	17	19	17	13	98.4976	75.9318	52.9548	74.28	76.53	0.013777	1.58094	-1.58202
92	11	3	17	19	20	75	124.657	75.9431	52.9458	74.14	76.55	0.013785	1.58104	-1.58203
92	11	3	17	19	24	38	107.609	75.935	52.8434	74.16	76.53	0.013792	1.58095	-1.58212
92	11	3	17	19	27	95	51.2384	75.9293	52.9218	74.17	76.51	0.013712	1.58097	-1.58212
92	11	3	17	19	31	57	36.4559	75.9293	52.974	74.75	76.53	0.013782	1.58114	-1.58201
92	11	3	17	19	35	14	141.021	75.9365	52.9172	74.48	76.55	0.013774	1.581	-1.58195
92	11	3	17	19	38	77	146.457	75.9242	52.9778	73.99	76.5	0.013578	1.58099	-1.58199
92	11	3	17	19	42	39	83.8414	75.9198	52.9588	74.08	76.48	0.01358	1.58092	-1.58209
92	11	3	17	19	46	2	3.06095	75.9165	52.8647	74.5	76.48	0.013612	1.58096	-1.582
92	11	3	17	19	49	59	12.2212	75.913	52.8503	74.59	76.48	0.013558	1.58091	-1.58209
92	11	3	17	19	53	21	104.255	75.9358	52.8693	74.43	76.51	0.013733	1.58117	-1.58199
92	11	3	17	19	56	78	49.745	75.9227	52.8352	74.64	76.5	0.013754	1.58093	-1.58208
92	11	3	17	20	0	41	96.3561	75.9329	52.9809	74.5	76.51	0.013763	1.58096	-1.58198
92	11	3	17	20	3	98	67.1956	75.9269	52.8492	74.23	76.53	0.013811	1.58102	-1.58204
92	11	3	17	20	7	60	95.9121	75.9267	52.9026	74.3	76.48	0.013719	1.58099	-1.58207
92	11	3	17	20	11	17	-17.5855	75.9274	52.8462	74.53	76.51	0.013712	1.58106	-1.58204
92	11	3	17	20	14	80	-52.1988	75.917	52.9232	74.95	76.5	0.013645	1.58091	-1.582
92	11	3	17	20	18	37	-44.5896	75.9214	52.8768	75.33	76.51	0.013565	1.58101	-1.58208
92	11	3	17	20	21	99	-41.6283	75.9305	52.6315	75.49	76.5	0.013599	1.58108	-1.58197
92	11	3	17	20	25	56	98.4378	75.923	52.9381	74.77	76.48	0.013581	1.58099	-1.58199
92	11	3	17	20	29	19	60.9352	75.9225	52.7677	74.55	76.53	0.013554	1.581	-1.58208
92	11	3	17	20	32	76	105.876	75.931	52.6411	74.55	76.5	0.013654	1.58099	-1.58206
92	11	3	17	20	36	38	76.8797	75.9118	52.3394	74.52	76.55	0.013656	1.58096	-1.58212
92	11	3	17	20	40	1	-37.4388	75.9139	51.8696	74.91	76.53	0.013611	1.58089	-1.58214
92	11	3	17	20	43	58	21.4727	75.9209	52.3065	75.11	76.5	0.013578	1.58104	-1.58201
92	11	3	17	20	47	20	-91.0565	75.9239	52.0208	75.51	76.57	0.013588	1.58104	-1.58194
92	11	3	17	20	50	78	14.2414	75.9236	52.0399	75.34	76.5	0.013612	1.58104	-1.58196
92	11	3	17	20	54	40	-19.9293	75.9252	51.8512	75.16	76.5	0.013607	1.58099	-1.58208
92	11	3	17	20	58	3	-34.1869	75.9186	51.9311	75.27	76.51	0.013565	1.58099	-1.58215
92	11	3	17	21	1	60	-57.2566	75.9245	52.3041	75.31	76.53	0.013548	1.58101	-1.58205
92	11	3	17	21	6	32	-102.393	75.9207	52.0798	75.56	76.5	0.013607	1.58099	-1.58205
92	11	3	17	21	10	0	-7.42312	75.9219	52.2858	75.31	76.51	0.013514	-0.00973	-1.5821
92	11	3	17	21	13	57	-84.9364	75.9226	51.9509	75.36	76.48	0.013651	1.58093	-1.58208
92	11	3	17	21	17	19	18.1364	75.9084	51.8561	75.29	76.53	0.013515	1.5811	-1.58215
92	11	3	17	21	20	82	6.98612	75.9223	51.9503	75.38	76.46	0.013444	1.58112	-1.58196
92	11	3	17	21	24	39	54.9841	75.9108	51.956	75.06	76.48	0.013513	1.5811	-1.58216
92	11	3	17	21	28	1	7.43414	75.9214	51.9799	74.91	76.53	0.013521	1.58115	-1.58193
92	11	3	17	21	31	58	39.028	75.9146	51.8779	74.95	76.51	0.013512	1.58089	-1.58219
92	11	3	17	21	35	21	7.50789	75.9309	51.9832	75.18	76.55	0.013588	1.58098	-1.58198
92	11	3	17	21	38	83	64.1568	75.9265	51.9622	75.04	76.53	0.013634	1.58103	-1.58195
92	11	3	17	21	42	41	49.4095	75.9224	51.8494	75	76.55	0.01362	1.58097	-1.58212
92	11	3	17	21	46	3	56.2952	75.9182	51.9504	74.71	76.53	0.01353	1.58112	-1.58202
92	11	3	17	21	49	60	-39.8556	75.9114	51.9824	74.77	76.51	0.013576	1.58106	-1.58203
92	11	3	17	21	53	23	8.77933	75.921	51.9574	75.07	76.6	0.013536	1.58104	-1.58207
92	11	3	17	21	56	85	30.7163	75.9249	51.9208	75.22	76.55	0.013571	1.58107	-1.58209
92	11	3	17	22	0	42	56.2917	75.9183	51.8525	75.11	76.55	0.013525	1.58107	-1.58206
92	11	3	17	22	4	5	-85.3785	75.9223	51.9309	75.02	76.59	0.013582	1.58102	-1.58211
92	11	3	17	22	7	62	35.8955	75.927	51.9735	75.18	76.6	0.013534	1.58108	-1.58197
92	11	3	17	22	11	24	17.8356	75.9195	51.9788	75.06	76.57	0.013544	1.58101	-1.58204
92	11	3	17	22	14	81	-2.0527	75.9163	51.9368	75.07	76.53	0.013583	1.58098	-1.58219
92	11	3	17	22	18	44	44.1027	75.923	51.9678	75.15	76.57	0.013579	1.58098	-1.58209
92	11	3	17	22	22	6	37.9085	75.9174	51.8704	75.02	76.5	0.013545	1.58105	-1.58217
92	11	3	17	22	25	63	0.074371	75.9219	51.8537	75.13	76.55	0.013599	1.58096	-1.58206
92	11	3	17	22	29	26	67.085	75.9151	51.8925	75.16	76.53	0.013575	1.58085	-1.58208
92	11	3	17	22	32	83	-52.6839	75.9194	51.8471	75.33	76.55	0.013569	1.58101	-1.58196
92	11	3	17	22	36	45	44.8889	75.9245	51.9442	75.15	76.57	0.013548	1.58095	-1.58217
92	11	3	17	22	40	8	32.5044	75.9105	51.9795	75	76.51	0.013583	1.58092	-1.58225
92	11	3	17	22	43	65	31.6468	75.9377	51.8994	74.93	76.55	0.013577	1.58112	-1.58187

[illegible]

92	11	3	17	22	47	27	-68.1024	75.9203	51.9885	75.15	76.53	0.013591	1.58102	-1.58199
92	11	3	17	22	50	84	-102.369	75.9259	51.921	75.45	76.57	0.01355	1.58108	-1.58199
92	11	3	17	22	54	47	64.4988	75.9144	51.8829	75.49	76.53	0.013564	1.581	-1.58189
92	11	3	17	22	58	9	11.3225	75.9216	51.9788	74.98	76.53	0.013575	1.58099	-1.58201
92	11	3	17	23	1	66	-85.0821	75.9311	51.9492	75.07	76.55	0.013519	1.58116	-1.58186
92	11	3	17	23	5	29	99.6053	75.9203	51.985	75.07	76.59	0.01352	1.58103	-1.58203
92	11	3	17	23	8	86	-21.4109	75.92	51.873	75.16	76.6	0.013608	1.58096	-1.58215
92	11	3	17	23	12	48	-43.5488	75.9198	51.8853	75.42	76.57	0.013538	1.58097	-1.5821
92	11	3	17	23	16	11	-93.9511	75.9159	51.9719	75.74	76.59	0.013607	1.58095	-1.58215
92	11	3	17	23	19	68	-59.7963	75.931	51.9635	75.79	76.59	0.013587	1.58106	-1.58203
92	11	3	17	23	23	30	-64.0844	75.9078	51.9508	75.78	76.55	0.013584	1.58098	-1.58217
92	11	3	17	23	26	87	10.984	75.9326	51.993	75.58	76.62	0.013543	1.58109	-1.58193
92	11	3	17	23	30	50	-70.3248	75.923	51.8902	75.58	76.59	0.013523	1.58099	-1.58201
92	11	3	17	23	34	12	-40.6237	75.9187	51.8592	75.63	76.57	0.013535	1.58105	-1.58201
92	11	3	17	23	37	69	15.7001	75.9266	51.8595	75.58	76.62	0.013586	1.58104	-1.58195
92	11	3	17	23	41	32	-70.5081	75.9213	51.8632	75.87	76.57	0.013584	1.58101	-1.582
92	11	3	17	23	44	94	-44.878	75.9211	51.8476	75.83	76.59	0.013535	1.5811	-1.58203
92	11	3	17	23	48	51	37.7222	75.9233	51.9427	75.69	76.55	0.013544	1.58113	-1.58196
92	11	3	17	23	52	14	-12.4152	75.9165	51.8507	75.63	76.53	0.013535	1.58116	-1.58207
92	11	3	17	23	55	71	-35.3309	75.9145	51.9213	75.76	76.59	0.013531	1.58104	-1.58206
92	11	3	17	23	59	33	-18.962	75.9255	51.9891	75.72	76.57	0.013556	1.58106	-1.58196
92	11	3	17	24	2	96	1.26954	75.9115	51.9343	75.42	76.5	0.013519	1.58098	-1.58208
92	11	3	17	24	6	53	26.7331	75.9272	51.8481	75.47	76.55	0.013598	1.58103	-1.582
92	11	3	17	24	10	15	58.986	75.9156	51.8664	75.34	76.6	0.013582	1.5811	-1.58196
92	11	3	17	24	13	72	15.4406	75.921	51.8674	75.07	76.59	0.013593	1.58095	-1.58208
92	11	3	17	24	17	35	-11.3354	75.9253	51.9875	75.4	76.51	0.013587	1.58101	-1.58201
92	11	3	17	24	20	92	-1.86582	75.9246	51.8744	75.51	76.55	0.013574	1.58104	-1.58199
92	11	3	17	24	24	55	0.149395	75.9174	51.8495	75.38	76.55	0.01355	1.58114	-1.58201
92	11	3	17	24	28	12	12.2936	75.9327	51.9098	75.2	76.62	0.013543	1.58108	-1.58199
92	11	3	17	24	31	74	-60.4308	75.9306	51.9093	75.16	76.57	0.013533	1.58107	-1.58202
92	11	3	17	24	35	37	34.9639	75.94	51.9915	75.29	76.55	0.013497	1.58112	-1.58189
92	11	3	17	24	38	94	6.12584	75.9284	51.9412	75.13	76.59	0.013577	1.58101	-1.582
92	11	3	17	24	42	56	-17.51	75.9277	51.8483	75.22	76.59	0.013563	1.58109	-1.58207
92	11	3	17	24	46	13	30.9027	75.9462	51.97	75.38	76.55	0.0136	1.58107	-1.58197
92	11	3	17	24	49	76	-49.9415	75.9358	51.8653	75.34	76.53	0.013564	1.58111	-1.58197
92	11	3	17	24	53	55	-17.4009	75.9263	51.9877	75.38	76.55	0.013532	1.58104	-1.58206
92	11	3	17	24	57	17	43.282	75.9352	51.9235	75.33	76.55	0.01352	1.5811	-1.58204
92	11	3	17	25	1	84	10.5732	75.9276	51.8882	75.6	76.57	0.013514	1.5811	-1.58202
92	11	3	17	25	5	41	-54.8616	75.9266	51.871	75.52	76.55	0.013563	1.58095	-1.58209
92	11	3	17	25	9	3	-19.7788	75.9237	51.984	75.45	76.51	0.01353	1.58111	-1.582
92	11	3	17	25	12	66	-44.4735	75.9406	51.8659	75.54	76.55	0.013584	1.58103	-1.58211
92	11	3	17	25	16	28	10.6852	75.9274	51.9709	75.61	76.59	0.013576	1.58095	-1.58204
92	11	3	17	25	19	86	43.8053	75.9199	51.8879	75.54	76.48	0.0135	1.58102	-1.58209
92	11	3	17	25	23	48	30.4582	75.9282	51.8618	75.22	76.59	0.013561	1.58105	-1.5821
92	11	3	17	25	27	5	67.3855	75.9252	51.9047	74.95	76.55	0.013535	1.58096	-1.58207
92	11	3	17	25	30	68	-32.2656	75.9236	51.9738	75.02	76.51	0.0135	1.58104	-1.58204
92	11	3	17	25	34	30	42.0136	75.9312	51.866	75.22	76.5	0.013531	1.58102	-1.5821
92	11	3	17	25	37	87	4.25683	75.9264	51.9804	75.24	76.55	0.013524	1.58106	-1.58208
92	11	3	17	25	41	50	-52.2694	75.9209	51.9334	75.52	76.55	0.013579	1.58101	-1.58224
92	11	3	17	25	45	7	-30.7297	75.9196	51.9558	75.69	76.57	0.013575	1.58106	-1.58211
92	11	3	17	25	48	69	63.8582	75.923	51.9529	75.56	76.57	0.013547	1.58098	-1.58214
92	11	3	17	25	52	32	15.2511	75.9281	51.8554	75.24	76.57	0.013598	1.58107	-1.58195
92	11	3	17	25	55	89	-8.95004	75.9289	51.9389	75.22	76.57	0.01356	1.58097	-1.58204
92	11	3	17	25	59	51	-85.9698	75.9221	51.9943	75.42	76.55	0.013552	1.58105	-1.5821
92	11	3	17	26	3	8	11.6967	75.9193	51.9072	75.54	76.53	0.013544	1.58106	-1.58205
92	11	3	17	26	6	71	3.39788	75.9188	51.9591	75.45	76.55	0.01355	1.58101	-1.58204
92	11	3	17	26	10	33	-32.3716	75.9265	51.9617	75.42	76.53	0.013499	1.58101	-1.58208
92	11	3	17	26	13	90	-43.1117	75.9253	51.8681	75.52	76.5	0.013549	1.58103	-1.5821
92	11	3	17	26	17	53	-6.07979	75.9389	51.8794	75.7	76.59	0.013588	1.5811	-1.58189
92	11	3	17	26	21	10	-16.8043	75.92	51.872	75.61	76.57	0.01357	1.581	-1.58207
92	11	3	17	26	24	72	-27.6527	75.925	51.8591	75.61	76.57	0.013554	1.58105	-1.58214
92	11	3	17	26	28	29	-12.7866	75.92	51.8779	75.43	76.55	0.013546	1.58103	-1.58218
92	11	3	17	26	31	92	-19.3326	75.9317	51.9096	75.65	76.59	0.013545	1.58111	-1.58203
92	11	3	17	26	35	54	23.6084	75.9249	51.8486	75.42	76.55	0.013565	1.58103	-1.58203
92	11	3	17	26	39	11	-19.2554	75.9149	51.9203	75.33	76.57	0.013532	1.58095	-1.58206
92	11	3	17	26	42	74	-3.80594	75.9327	51.8432	75.38	76.59	0.013543	1.58105	-1.58201
92	11	3	17	26	46	31	43.2077	75.9211	51.9482	75.42	76.59	0.013602	1.58098	-1.58206
92	11	3	17	26	49	93	-38.0338	75.916	51.9714	75.6	76.55	0.013664	1.58085	-1.58208
92	11	3	17	26	53	56	-62.5648	75.9335	51.9087	75.83	76.51	0.013561	1.58105	-1.58193
92	11	3	17	26	57	13	3.47301	75.9259	51.9808	75.67	76.5	0.013586	1.58099	-1.58211

92	11	3	17	27	0	75	45.9717	75.9337	51.9071	75.51	76.57	0.013627	1.58109	-1.58198
92	11	3	17	27	4	32	-5.89227	75.9457	51.9937	75.4	76.66	0.013632	1.58131	-1.58185
92	11	3	17	27	7	95	-6.0786	75.9268	51.9698	75.2	76.57	0.01363	1.58103	-1.58214

APPENDIX B

EXAMPLE OF REDUCED DATA FROM A DROPLET-EVAPORATION TEST WITHOUT AIRFLOW

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H
Substance:	WHO Water
Target Drop Size:	400 µm
Target Air Velocity:	0 ft/min
Target Temperature:	Ambient °F
Target RH:	Ambient %
Initial # of Drops:	100
Average DSD Fiber Diameter in µm:	97.3
Test-Substance Density in g/mL:	1.00

Initial Drop Time, s:	921
Initial Total Mass, µg:	1093.1
Average Initial Drop Mass, µg:	10.93
Average Initial Drop Size, µm:	293
Ending Evaporation Time, s:	1396
Ending Total Mass, µg:	-7.4
Overall Evaporation Period, s:	475
Total Mass Loss, µg:	1100.5
Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
0	-6.9	75.7	52.0	75.5	52.0	76.4	0.0	1.6	-1.6
4	-7.1	75.8	52.4	75.6	52.4	76.4	0.0	1.6	-1.6
7	-7.1	75.8	52.7	75.4	54.4	76.4	0.0	1.6	-1.6
11	-6.4	75.8	52.9	75.4	54.6	76.4	0.0	1.6	-1.6
15	-7.6	75.8	52.4	75.6	52.4	76.4	0.0	1.6	-1.6
24	-6.2	75.8	52.3	75.6	52.3	76.4	0.0	1.6	-1.6
28	-6.6	75.8	51.9	75.5	51.9	76.4	0.0	1.6	-1.6
31	-6.4	75.8	52.4	75.6	52.4	76.4	0.0	1.6	-1.6
35	-6.7	75.8	52.3	75.7	52.3	76.4	0.0	1.6	-1.6
38	-7.0	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
42	-6.4	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
45	-5.7	75.8	52.1	75.7	52.1	76.4	0.0	1.6	-1.6
49	-6.3	75.8	52.2	75.9	52.2	76.4	0.0	1.6	-1.6
52	-6.6	75.8	52.2	75.9	52.2	76.4	0.0	1.6	-1.6
56	-6.4	75.8	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
59	-6.5	75.8	51.8	75.3	53.6	76.4	0.0	1.6	-1.6
63	-7.1	75.8	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
66	-7.2	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
70	-7.1	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
73	-6.6	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
77	-6.5	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
80	-6.4	75.8	51.9	75.0	53.6	76.5	0.0	1.6	-1.6
84	-7.2	75.8	51.9	75.0	53.6	76.4	0.0	1.6	-1.6
87	-7.5	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
91	-5.7	75.8	51.9	74.9	53.6	76.4	0.0	1.6	-1.6
94	-8.4	75.8	51.9	75.1	53.6	76.4	0.0	1.6	-1.6
98	-7.9	75.8	51.8	75.2	53.5	76.4	0.0	1.6	-1.6
101	-6.7	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
105	-5.9	75.8	52.0	75.3	53.7	76.4	0.0	1.6	-1.6
108	-5.8	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
112	-7.6	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
115	-6.6	75.8	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
119	-6.2	75.8	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
122	-5.2	75.8	52.0	75.9	52.0	76.4	0.0	1.6	-1.6
126	-5.9	75.8	51.9	75.5	53.6	76.4	0.0	1.6	-1.6
129	-7.2	75.8	51.8	75.1	53.6	76.4	0.0	1.6	-1.6
133	-6.5	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
136	-6.6	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
140	-7.2	75.8	52.0	75.3	53.7	76.3	0.0	1.6	-1.6
143	-7.3	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
147	-7.1	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
150	-6.6	75.8	52.0	75.3	53.7	76.4	0.0	1.6	-1.6
154	-7.4	75.8	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
157	-6.0	75.8	52.0	75.4	53.7	76.4	0.0	1.6	-1.6
161	-6.5	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
164	-7.4	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
168	-7.3	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
171	-6.1	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
175	-6.8	75.8	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
178	-6.9	75.8	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
182	-6.8	75.8	51.8	75.3	53.6	76.4	0.0	1.6	-1.6
185	-7.0	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
189	-7.2	75.8	52.0	75.2	53.7	76.5	0.0	1.6	-1.6

[illegible]

[illegible]
Initial [illegible]
average [illegible]
[illegible]
[illegible] in [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Airplane Wave, [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H		Initial Drop Time, s:	921
Substance:	WHO Water		Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm		Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min		Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F		Ending Evaporation Time, s:	1396
Target RH:	Ambient %		Ending Total Mass, µg:	-7.4
Initial # of Drops:		100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:		97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:		1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
192	-7.9	75.8	51.9	75.1	53.6	76.4	0.0	1.6	-1.6
196	-6.2	75.8	52.0	74.9	53.7	76.4	0.0	1.6	-1.6
199	-5.6	75.8	51.9	75.3	53.7	76.5	0.0	1.6	-1.6
203	-6.7	75.8	51.9	75.4	53.7	76.4	0.0	1.6	-1.6
206	-6.9	75.8	51.9	75.5	53.6	76.4	0.0	1.6	-1.6
210	-7.7	75.8	51.9	75.5	51.9	76.4	0.0	1.6	-1.6
213	-7.6	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
217	-7.2	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
220	-6.8	75.8	51.8	75.7	51.8	76.4	0.0	1.6	-1.6
224	-7.3	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
228	-6.9	75.8	52.0	75.7	52.0	76.4	0.0	1.6	-1.6
232	-6.3	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
235	-6.5	75.8	52.0	75.5	53.7	76.4	0.0	1.6	-1.6
239	-8.0	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
242	-6.9	75.8	51.9	75.5	51.9	76.4	0.0	1.6	-1.6
246	-6.6	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
249	-7.0	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
253	-8.5	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
256	-7.1	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
260	-6.1	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
263	-6.5	75.8	52.0	75.9	52.0	76.4	0.0	1.6	-1.6
267	-6.9	75.8	51.8	75.8	51.8	76.4	0.0	1.6	-1.6
270	-7.2	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
274	-7.9	75.8	51.9	75.5	51.9	76.4	0.0	1.6	-1.6
277	-7.2	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
281	-7.3	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
284	-6.9	75.8	51.9	75.5	53.6	76.4	0.0	1.6	-1.6
288	-6.7	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
291	-7.3	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
295	-7.9	75.8	52.0	75.7	52.0	76.4	0.0	1.6	-1.6
298	-8.2	75.8	51.9	75.4	53.6	76.3	0.0	1.6	-1.6
302	-7.5	75.8	52.0	75.4	53.7	76.4	0.0	1.6	-1.6
305	-7.0	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
309	-7.0	75.8	52.0	75.7	52.0	76.4	0.0	1.6	-1.6
312	-7.9	75.8	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
316	-7.1	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
319	-6.8	75.8	52.0	75.4	53.7	76.4	0.0	1.6	-1.6
323	-6.8	75.8	51.9	75.1	53.6	76.4	0.0	1.6	-1.6
326	-7.5	75.8	51.9	75.1	53.6	76.4	0.0	1.6	-1.6
330	-7.7	75.8	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
333	-7.1	75.8	51.9	75.4	53.7	76.4	0.0	1.6	-1.6
337	-6.2	75.8	52.0	75.5	52.0	76.4	0.0	1.6	-1.6
340	-7.1	75.8	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
344	-7.3	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
347	-6.8	75.8	51.9	75.5	53.6	76.4	0.0	1.6	-1.6
351	-6.4	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
354	-7.7	75.8	51.9	75.8	51.9	76.3	0.0	1.6	-1.6
358	-7.4	75.8	52.0	75.7	52.0	76.4	0.0	1.6	-1.6
361	-7.6	75.8	51.8	75.7	51.8	76.4	0.0	1.6	-1.6
365	-7.8	75.8	51.9	75.8	51.9	76.4	0.0	1.6	-1.6
368	-6.9	75.8	51.9	75.9	51.9	76.4	0.0	1.6	-1.6
372	-7.9	75.8	51.9	75.9	51.9	76.4	0.0	1.6	-1.6
375	-7.8	75.8	51.9	76.2	51.9	76.4	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H	Initial Drop Time, s:	921
Substance:	WHO Water	Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min	Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F	Ending Evaporation Time, s:	1396
Target RH:	Ambient %	Ending Total Mass, µg:	-7.4
Initial # of Drops:	100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
379	-7.6	75.8	51.9	76.3	51.9	76.4	0.0	1.6	-1.6
382	-6.7	75.8	51.8	76.2	51.8	76.4	0.0	1.6	-1.6
386	65.1	75.8	52.0	75.7	52.0	76.4	0.0	1.6	-1.6
389	-14.2	75.8	52.0	75.5	52.0	76.5	0.0	1.6	-1.6
393	-77.1	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
396	32.5	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
400	-46.6	75.8	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
403	-8.1	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
407	-54.3	75.8	51.8	75.9	51.8	76.4	0.0	1.6	-1.6
410	-1.0	75.8	51.9	76.0	51.9	76.4	0.0	1.6	-1.6
414	28.6	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
418	-14.0	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
421	-7.5	75.8	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
424	11.6	75.8	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
428	-65.8	75.8	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
431	-80.8	75.8	51.9	75.8	51.9	76.5	0.0	1.6	-1.6
435	-94.0	75.8	51.9	75.9	51.9	76.4	0.0	1.6	-1.6
438	-98.4	75.8	52.0	76.0	52.0	76.4	0.0	1.6	-1.6
442	18.9	75.8	51.8	75.8	51.8	76.4	0.0	1.6	-1.6
446	17.9	75.8	51.9	75.4	53.6	76.5	0.0	1.6	-1.6
449	-29.9	75.8	52.0	75.4	53.7	76.4	0.0	1.6	-1.6
452	33.1	75.8	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
457	10.1	75.8	52.0	75.3	53.7	76.4	0.0	1.6	-1.6
461	45.4	75.8	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
464	28.3	75.8	51.9	75.0	53.6	76.4	0.0	1.6	-1.6
468	-50.7	75.8	52.0	75.1	53.7	76.5	0.0	1.6	-1.6
471	-2.7	75.8	51.9	75.1	53.6	76.4	0.0	1.6	-1.6
475	-31.5	75.8	51.9	75.5	53.7	76.5	0.0	1.6	-1.6
478	-17.0	75.8	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
482	7.2	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
485	40.4	75.8	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
489	11.8	75.8	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
492	23.4	75.9	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
496	-36.5	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
499	-25.4	75.8	51.8	75.6	51.8	76.4	0.0	1.6	-1.6
503	-17.8	75.8	51.8	75.6	51.8	76.4	0.0	1.6	-1.6
506	-9.2	75.8	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
510	-39.5	75.8	51.8	75.3	53.6	76.5	0.0	1.6	-1.6
513	-36.5	75.8	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
517	67.9	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
520	-4.6	75.8	51.9	75.5	53.6	76.5	0.0	1.6	-1.6
524	17.6	75.8	51.8	75.5	53.5	76.5	0.0	1.6	-1.6
527	-86.0	75.8	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
531	-70.2	75.8	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
534	-5.5	75.9	52.0	75.9	52.0	76.4	0.0	1.6	-1.6
538	-62.6	75.9	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
541	-25.1	75.8	51.9	75.9	51.9	76.5	0.0	1.6	-1.6
545	-10.4	75.8	51.9	75.9	51.9	76.4	0.0	1.6	-1.6
548	7.4	75.9	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
552	10.8	75.8	52.0	75.6	52.0	76.5	0.0	1.6	-1.6
555	-22.5	75.9	51.9	75.5	53.6	76.4	0.0	1.6	-1.6
559	-86.6	75.9	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
562	-76.4	75.8	51.8	75.7	51.8	76.5	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H	Initial Drop Time, s:	921
Substance:	WHO Water	Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min	Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F	Ending Evaporation Time, s:	1396
Target RH:	Ambient %	Ending Total Mass, µg:	-7.4
Initial # of Drops:	100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
566	-26.7	75.9	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
569	60.4	75.8	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
573	-35.0	75.8	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
576	-37.5	75.9	51.9	75.8	51.9	76.5	0.0	1.6	-1.6
580	46.4	75.8	51.8	75.9	51.8	76.4	0.0	1.6	-1.6
583	-66.2	75.9	52.0	75.8	52.0	76.4	0.0	1.6	-1.6
587	-49.6	75.9	52.0	75.9	52.0	76.5	0.0	1.6	-1.6
590	-51.1	75.9	51.9	76.1	51.9	76.5	0.0	1.6	-1.6
594	-2.5	75.9	51.9	75.9	51.9	76.5	0.0	1.6	-1.6
597	27.2	75.9	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
601	-5.1	75.9	52.0	75.4	53.7	76.4	0.0	1.6	-1.6
604	14.2	75.9	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
608	-43.0	75.9	51.9	75.5	53.6	76.5	0.0	1.6	-1.6
611	-70.8	75.9	52.0	75.6	52.0	76.4	0.0	1.6	-1.6
615	-44.0	75.9	52.0	75.9	52.0	76.4	0.0	1.6	-1.6
618	-27.9	75.9	51.9	75.9	51.9	76.5	0.0	1.6	-1.6
622	-67.1	75.9	52.0	76.0	52.0	76.4	0.0	1.6	-1.6
625	-105.6	75.9	51.8	76.1	51.8	76.5	0.0	1.6	-1.6
629	-88.2	75.9	51.9	76.2	51.9	76.4	0.0	1.6	-1.6
632	-14.7	75.9	52.0	76.2	52.0	76.4	0.0	1.6	-1.6
636	-84.5	75.9	52.0	76.2	52.0	76.4	0.0	1.6	-1.6
639	42.2	75.9	51.9	75.9	51.9	76.4	0.0	1.6	-1.6
643	-97.4	75.9	51.8	75.9	51.8	76.4	0.0	1.6	-1.6
646	-95.9	75.9	52.0	76.1	52.0	76.4	0.0	1.6	-1.6
650	-2.8	75.9	52.0	76.1	52.0	76.5	0.0	1.6	-1.6
653	34.4	75.9	51.8	75.9	51.8	76.5	0.0	1.6	-1.6
657	-51.8	75.9	51.8	75.8	51.8	76.5	0.0	1.6	-1.6
660	31.5	75.9	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
664	-57.4	75.9	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
667	1.5	75.9	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
671	62.8	75.9	51.9	75.4	53.6	76.5	0.0	1.6	-1.6
674	58.3	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
678	9.0	75.9	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
681	25.2	75.9	52.0	75.2	53.7	76.4	0.0	1.6	-1.6
686	44.2	75.9	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
689	23.1	75.9	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
693	-4.0	75.9	52.0	75.3	53.7	76.4	0.0	1.6	-1.6
696	-15.9	75.9	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
700	37.7	75.9	51.9	75.6	51.9	76.4	0.0	1.6	-1.6
703	-22.8	75.9	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
707	-9.7	75.9	52.0	75.6	52.0	76.5	0.0	1.6	-1.6
710	23.0	75.9	51.8	75.5	53.6	76.4	0.0	1.6	-1.6
714	17.8	75.9	52.0	75.3	53.7	76.5	0.0	1.6	-1.6
717	22.4	75.9	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
721	12.7	75.9	51.8	75.2	53.6	76.4	0.0	1.6	-1.6
724	40.5	75.8	51.8	75.0	53.5	76.5	0.0	1.6	-1.6
728	31.8	75.9	52.0	75.0	53.7	76.4	0.0	1.6	-1.6
731	57.8	75.9	51.9	75.2	53.6	76.4	0.0	1.6	-1.6
735	-5.6	75.9	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
738	15.7	75.9	52.0	75.1	53.7	76.4	0.0	1.6	-1.6
742	-6.6	75.9	52.0	75.0	53.7	76.5	0.0	1.6	-1.6
745	74.1	75.9	51.9	75.1	53.6	76.5	0.0	1.6	-1.6
749	100.1	75.9	51.9	74.9	53.6	76.5	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H	Initial Drop Time, s:	921
Substance:	WHO Water	Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min	Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F	Ending Evaporation Time, s:	1396
Target RH:	Ambient %	Ending Total Mass, µg:	-7.4
Initial # of Drops:	100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
752	40.5	75.9	51.9	74.9	53.6	76.5	0.0	1.6	-1.6
756	-15.0	75.9	51.9	74.9	53.6	76.5	0.0	1.6	-1.6
759	-10.3	75.9	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
763	44.1	75.9	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
766	-53.4	75.9	51.9	75.4	53.6	76.5	0.0	1.6	-1.6
770	-21.8	75.9	51.9	75.3	53.6	76.4	0.0	1.6	-1.6
773	-19.1	75.9	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
777	37.4	75.9	51.8	75.4	53.6	76.4	0.0	1.6	-1.6
780	-7.8	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
784	13.8	75.9	51.9	75.4	53.6	76.4	0.0	1.6	-1.6
787	11.3	75.9	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
791	-8.0	75.9	51.8	75.4	53.6	76.5	0.0	1.6	-1.6
794	-37.0	75.9	51.8	75.4	53.5	76.5	0.0	1.6	-1.6
798	-16.1	75.9	51.9	75.4	53.6	76.5	0.0	1.6	-1.6
801	288.1	75.9	51.9	75.5	51.9	76.4	0.0	1.6	-1.6
805	-6.8	75.9	52.0	75.7	52.0	76.5	0.0	1.6	-1.6
810	-7.2	75.9	51.9	75.8	51.9	76.4	0.0	1.6	-1.6
814	-7.2	75.9	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
818	-6.5	75.9	51.8	76.0	51.8	76.5	0.0	1.6	-1.6
821	-7.5	75.9	51.9	75.9	51.9	76.5	0.0	1.6	-1.6
825	-6.6	75.9	52.0	75.5	52.0	76.5	0.0	1.6	-1.6
829	-7.6	75.9	51.8	75.7	51.8	76.5	0.0	1.6	-1.6
832	-7.0	75.9	51.9	75.7	51.9	76.4	0.0	1.6	-1.6
836	-7.2	75.9	51.9	75.7	51.9	76.5	0.0	1.6	-1.6
839	-7.0	75.8	51.9	76.0	51.9	76.5	0.0	1.6	-1.6
843	-6.5	75.8	51.9	76.4	51.9	76.5	0.0	1.6	-1.6
847	-7.3	75.8	51.9	76.2	51.9	76.5	0.0	1.6	-1.6
850	-7.5	75.8	52.0	76.6	50.4	76.4	0.0	1.6	-1.6
854	-6.6	75.8	51.9	76.7	50.3	76.4	0.0	1.6	-1.6
857	-7.8	75.8	51.9	76.6	50.3	76.5	0.0	1.6	-1.6
861	-6.9	75.8	51.9	76.8	50.3	76.5	0.0	1.6	-0.0
865	-6.2	75.8	52.0	76.0	52.0	76.5	0.0	1.6	-0.0
868	-7.6	75.8	52.4	75.8	52.4	76.5	0.0	1.6	-0.0
872	-6.6	75.8	52.9	76.2	52.9	76.5	0.0	1.6	-0.0
876	-5.8	75.8	52.9	75.8	52.9	76.6	0.0	1.6	-0.0
879	-5.9	75.8	52.9	76.3	52.9	76.5	0.0	1.6	-0.0
883	-6.7	75.8	53.0	76.1	53.0	76.5	0.0	1.6	-0.0
887	-6.4	75.8	52.8	75.4	54.6	76.5	0.0	1.6	-0.0
890	-6.5	75.8	52.9	74.4	56.4	76.4	0.0	1.6	-0.0
894	-6.8	75.8	53.0	74.7	54.7	76.5	0.0	1.6	-0.0
898	-6.6	75.8	52.9	75.8	52.9	76.4	0.0	1.6	-0.0
902	-6.8	75.8	53.0	75.8	53.0	76.4	0.0	1.6	-0.0
905	-6.6	75.8	52.9	75.7	52.9	76.4	0.0	1.6	-0.0
909	-7.5	75.8	52.9	75.7	52.9	76.4	0.0	1.6	-1.6
912	-9.1	75.8	52.8	74.8	54.6	76.4	0.0	1.6	-1.6
916	1201.0	75.8	52.9	74.6	54.6	76.5	0.0	1.6	-1.6
921	1093.1	75.8	52.8	75.3	54.6	76.4	0.0	-0.0	-1.6
924	1096.6	75.8	52.8	75.5	54.6	76.4	0.0	1.6	-1.6
928	1114.1	75.9	52.9	75.2	54.7	76.5	0.0	1.6	-1.6
932	1104.0	75.8	53.0	75.2	54.7	76.5	0.0	1.6	-1.6
935	1155.2	75.8	52.9	74.8	54.7	76.5	0.0	1.6	-1.6
939	1099.5	75.8	52.8	74.8	54.6	76.5	0.0	1.6	-1.6
942	1117.6	75.9	52.9	74.5	56.4	76.5	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H	Initial Drop Time, s:	921
Substance:	WHO Water	Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min	Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F	Ending Evaporation Time, s:	1396
Target RH:	Ambient %	Ending Total Mass, µg:	-7.4
Initial # of Drops:	100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
946	1177.4	75.8	53.0	73.9	56.5	76.5	0.0	1.6	-1.6
950	1142.2	75.9	52.9	73.5	56.4	76.4	0.0	1.6	-1.6
953	1091.8	75.8	53.0	73.6	56.4	76.4	0.0	1.6	-1.6
957	1113.1	75.9	52.9	73.5	58.3	76.5	0.0	1.6	-1.6
960	1033.8	75.9	52.9	73.4	58.2	76.5	0.0	1.6	-1.6
964	1046.4	75.9	52.8	73.5	56.3	76.5	0.0	1.6	-1.6
968	1006.9	75.9	52.9	73.4	58.2	76.5	0.0	1.6	-1.6
971	997.2	75.9	52.8	73.7	56.3	76.4	0.0	1.6	-1.6
975	1056.9	75.9	53.0	73.2	58.3	76.5	0.0	1.6	-1.6
978	967.7	75.9	52.9	73.0	58.2	76.5	0.0	1.6	-1.6
982	1026.2	75.9	52.8	73.1	58.1	76.5	0.0	1.6	-1.6
986	958.8	75.9	52.9	73.3	58.2	76.5	0.0	1.6	-1.6
989	1017.5	75.9	52.8	73.9	56.3	76.5	0.0	1.6	-1.6
993	953.3	75.9	52.9	73.1	58.2	76.4	0.0	1.6	-1.6
996	932.1	75.9	52.8	73.8	56.3	76.5	0.0	1.6	-1.6
1000	871.1	75.9	52.9	73.9	56.4	76.5	0.0	1.6	-1.6
1004	924.8	75.9	52.8	73.7	56.3	76.5	0.0	1.6	-1.6
1007	875.9	75.9	52.9	73.8	56.4	76.5	0.0	1.6	-1.6
1011	907.1	75.9	52.9	74.1	56.3	76.4	0.0	1.6	-1.6
1014	869.4	75.9	52.9	73.6	56.4	76.5	0.0	1.6	-1.6
1018	843.4	75.9	52.8	73.6	56.3	76.4	0.0	-0.0	-1.6
1022	879.3	75.9	52.9	73.0	58.2	76.5	0.0	-0.0	-1.6
1025	776.5	75.9	52.9	73.7	56.3	76.5	0.0	1.6	-1.6
1029	811.4	75.9	53.0	73.2	58.3	76.5	0.0	1.6	-1.6
1033	765.0	75.9	52.9	73.6	56.3	76.5	0.0	1.6	-1.6
1036	808.9	75.9	52.9	73.0	58.2	76.5	0.0	1.6	-1.6
1040	717.2	75.9	52.9	74.0	56.3	76.5	0.0	1.6	-1.6
1043	686.1	75.9	52.8	74.4	56.3	76.5	0.0	1.6	-1.6
1047	802.9	75.9	52.9	73.9	56.4	76.5	0.0	1.6	-1.6
1051	737.0	75.9	52.8	73.5	56.3	76.5	0.0	1.6	-1.6
1054	784.0	75.9	52.8	73.3	58.1	76.5	0.0	1.6	-1.6
1058	716.4	75.9	52.9	73.5	58.2	76.5	0.0	1.6	-1.6
1061	754.8	75.9	52.8	73.7	56.3	76.5	0.0	1.6	-1.6
1065	665.6	75.9	52.9	73.4	58.2	76.5	0.0	1.6	-1.6
1069	690.2	75.9	52.8	73.2	58.1	76.4	0.0	1.6	-1.6
1072	682.5	75.9	53.0	73.0	58.3	76.5	0.0	-0.0	-1.6
1076	687.2	75.9	52.8	73.8	56.3	76.4	0.0	-0.0	-1.6
1080	640.0	75.9	52.8	73.5	56.3	76.5	0.0	1.6	-1.6
1083	569.3	75.9	52.9	73.8	56.3	76.5	0.0	1.6	-1.6
1087	635.1	75.9	52.9	73.7	56.3	76.5	0.0	1.6	-1.6
1090	523.1	75.9	52.9	74.0	56.4	76.5	0.0	1.6	-1.6
1094	541.5	75.9	53.0	74.3	56.5	76.5	0.0	1.6	-1.6
1098	545.8	75.9	52.9	74.3	56.3	76.5	0.0	1.6	-1.6
1101	582.5	75.9	52.9	73.9	56.3	76.5	0.0	1.6	-1.6
1105	519.6	75.9	52.9	73.6	56.4	76.5	0.0	1.6	-1.6
1108	515.6	75.9	52.8	73.5	56.3	76.6	0.0	1.6	-1.6
1112	512.6	75.9	53.0	73.4	58.3	76.5	0.0	1.6	-1.6
1116	460.1	75.9	53.0	73.7	56.5	76.5	0.0	1.6	-1.6
1119	568.1	75.9	52.9	73.9	56.3	76.6	0.0	1.6	-1.6
1123	561.6	75.9	53.0	73.5	56.5	76.5	0.0	-0.0	-1.6
1127	551.3	75.9	53.0	72.9	58.3	76.4	0.0	-0.0	-1.6
1130	375.2	75.9	52.9	73.6	56.3	76.5	0.0	1.6	-1.6
1134	465.5	75.9	53.0	74.2	56.5	76.5	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H
Substance:	WHO Water
Target Drop Size:	400 µm
Target Air Velocity:	0 ft/min
Target Temperature:	Ambient °F
Target RH:	Ambient %
Initial # of Drops:	100
Average DSD Fiber Diameter in µm:	97.3
Test-Substance Density in g/mL:	1.00

Initial Drop Time, s:	921
Initial Total Mass, µg:	1093.1
Average Initial Drop Mass, µg:	10.93
Average Initial Drop Size, µm:	293
Ending Evaporation Time, s:	1396
Ending Total Mass, µg:	-7.4
Overall Evaporation Period, s:	475
Total Mass Loss, µg:	1100.5
Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1137	476.4	75.9	52.9	73.8	56.4	76.5	0.0	1.6	-1.6
1141	478.7	75.9	53.0	73.5	56.5	76.5	0.0	1.6	-1.6
1145	423.1	75.9	52.9	73.5	58.2	76.5	0.0	1.6	-1.6
1148	403.6	75.9	52.8	73.6	56.3	76.5	0.0	1.6	-1.6
1152	434.8	75.9	52.8	73.7	56.3	76.6	0.0	1.6	-1.6
1156	458.5	75.9	52.9	73.1	58.2	76.5	0.0	1.6	-1.6
1160	368.1	75.9	53.0	73.0	58.3	76.5	0.0	1.6	-1.6
1164	381.5	75.9	52.9	73.3	58.2	76.5	0.0	1.6	-1.6
1167	392.5	75.9	52.8	73.4	58.1	76.5	0.0	1.6	-1.6
1171	323.6	75.9	52.9	74.1	56.4	76.5	0.0	1.6	-1.6
1174	291.5	75.9	52.9	74.3	56.3	76.5	0.0	1.6	-1.6
1178	325.9	75.9	52.9	73.9	56.3	76.5	0.0	1.6	-1.6
1182	341.8	75.9	52.9	74.1	56.3	76.5	0.0	1.6	-1.6
1185	310.4	75.9	52.9	73.8	56.3	76.6	0.0	1.6	-1.6
1189	294.2	75.9	53.0	73.9	56.4	76.5	0.0	1.6	-1.6
1192	257.6	75.9	52.9	74.2	56.4	76.5	0.0	1.6	-1.6
1196	211.0	75.9	52.8	74.4	56.3	76.5	0.0	1.6	-1.6
1200	229.0	75.9	52.9	74.5	54.6	76.5	0.0	1.6	-1.6
1203	308.4	75.9	52.8	74.4	56.3	76.5	0.0	1.6	-1.6
1207	234.7	75.9	52.9	73.9	56.4	76.5	0.0	1.6	-1.6
1211	238.2	75.9	52.9	73.9	56.4	76.4	0.0	1.6	-1.6
1214	244.9	75.9	52.9	73.9	56.3	76.5	0.0	1.6	-1.6
1218	227.3	75.9	52.8	74.0	56.3	76.5	0.0	1.6	-1.6
1221	205.4	75.9	52.9	74.2	56.4	76.5	0.0	1.6	-1.6
1225	257.2	75.9	52.8	73.9	56.3	76.4	0.0	-0.0	-1.6
1229	209.2	75.9	52.8	74.0	56.3	76.5	0.0	-0.0	-1.6
1232	216.2	75.9	52.9	74.1	56.4	76.5	0.0	1.6	-1.6
1236	270.7	75.9	53.0	74.3	56.5	76.5	0.0	1.6	-1.6
1239	244.4	75.9	52.9	74.1	56.4	76.5	0.0	1.6	-1.6
1243	159.7	75.9	52.8	74.0	56.3	76.5	0.0	1.6	-1.6
1247	181.0	75.9	52.9	74.1	56.4	76.5	0.0	1.6	-1.6
1250	229.7	75.9	53.0	74.1	56.5	76.5	0.0	1.6	-1.6
1254	208.8	75.9	52.9	73.7	56.4	76.5	0.0	1.6	-1.6
1257	116.7	75.9	53.0	73.6	56.5	76.5	0.0	1.6	-1.6
1261	129.1	75.9	52.9	73.9	56.4	76.6	0.0	1.6	-1.6
1265	131.1	75.9	53.0	73.7	56.5	76.5	0.0	1.6	-1.6
1268	190.6	75.9	53.0	73.5	56.5	76.5	0.0	1.6	-1.6
1272	128.8	75.9	52.9	73.6	56.4	76.6	0.0	1.6	-1.6
1275	70.2	75.9	53.0	74.1	56.5	76.6	0.0	1.6	-1.6
1279	127.4	75.9	52.9	74.3	56.3	76.6	0.0	1.6	-1.6
1283	98.5	75.9	53.0	74.3	56.4	76.5	0.0	1.6	-1.6
1286	124.7	75.9	52.9	74.1	56.4	76.6	0.0	1.6	-1.6
1290	107.6	75.9	52.8	74.2	56.3	76.5	0.0	1.6	-1.6
1293	51.2	75.9	52.9	74.2	56.4	76.5	0.0	1.6	-1.6
1297	36.5	75.9	53.0	74.8	54.7	76.5	0.0	1.6	-1.6
1301	141.0	75.9	52.9	74.5	56.4	76.6	0.0	1.6	-1.6
1304	146.5	75.9	53.0	74.0	56.5	76.5	0.0	1.6	-1.6
1308	83.8	75.9	53.0	74.1	56.4	76.5	0.0	1.6	-1.6
1312	3.1	75.9	52.9	74.5	54.6	76.5	0.0	1.6	-1.6
1315	12.2	75.9	52.9	74.6	54.6	76.5	0.0	1.6	-1.6
1319	104.3	75.9	52.9	74.4	56.3	76.5	0.0	1.6	-1.6
1322	49.7	75.9	52.8	74.6	54.6	76.5	0.0	1.6	-1.6
1326	96.4	75.9	53.0	74.5	54.7	76.5	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H
Substance:	WHO Water
Target Drop Size:	400 µm
Target Air Velocity:	0 ft/min
Target Temperature:	Ambient °F
Target RH:	Ambient %
Initial # of Drops:	100
Average DSD Fiber Diameter in µm:	97.3
Test-Substance Density in g/mL:	1.00

Initial Drop Time, s:	921
Initial Total Mass, µg:	1093.1
Average Initial Drop Mass, µg:	10.93
Average Initial Drop Size, µm:	293
Ending Evaporation Time, s:	1396
Ending Total Mass, µg:	-7.4
Overall Evaporation Period, s:	475
Total Mass Loss, µg:	1100.5
Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1329	67.2	75.9	52.8	74.2	56.3	76.5	0.0	1.6	-1.6
1333	95.9	75.9	52.9	74.3	56.4	76.5	0.0	1.6	-1.6
1337	-17.6	75.9	52.8	74.5	54.6	76.5	0.0	1.6	-1.6
1340	-52.2	75.9	52.9	75.0	54.7	76.5	0.0	1.6	-1.6
1344	-44.6	75.9	52.9	75.3	54.6	76.5	0.0	1.6	-1.6
1347	-41.6	75.9	52.6	75.5	54.4	76.5	0.0	1.6	-1.6
1351	98.4	75.9	52.9	74.8	54.7	76.5	0.0	1.6	-1.6
1355	60.9	75.9	52.8	74.6	54.5	76.5	0.0	1.6	-1.6
1358	105.9	75.9	52.6	74.6	54.4	76.5	0.0	1.6	-1.6
1362	76.9	75.9	52.3	74.5	54.1	76.6	0.0	1.6	-1.6
1366	-37.4	75.9	51.9	74.9	53.6	76.5	0.0	1.6	-1.6
1369	21.5	75.9	52.3	75.1	54.0	76.5	0.0	1.6	-1.6
1373	-91.1	75.9	52.0	75.5	52.0	76.6	0.0	1.6	-1.6
1376	14.2	75.9	52.0	75.3	53.8	76.5	0.0	1.6	-1.6
1380	-19.9	75.9	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
1384	-34.2	75.9	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
1387	-57.3	75.9	52.3	75.3	54.0	76.5	0.0	1.6	-1.6
1392	-102.4	75.9	52.1	75.6	52.1	76.5	0.0	-0.0	-1.6
1396	-7.4	75.9	52.3	75.3	54.0	76.5	0.0	1.6	-1.6
1399	-84.9	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
1403	18.1	75.9	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
1406	7.0	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
1410	55.0	75.9	52.0	75.1	53.7	76.5	0.0	1.6	-1.6
1414	7.4	75.9	52.0	74.9	53.7	76.5	0.0	1.6	-1.6
1417	39.0	75.9	51.9	75.0	53.6	76.5	0.0	1.6	-1.6
1421	7.5	75.9	52.0	75.2	53.7	76.6	0.0	1.6	-1.6
1424	64.2	75.9	52.0	75.0	53.7	76.5	0.0	1.6	-1.6
1428	49.4	75.9	51.8	75.0	53.6	76.6	0.0	1.6	-1.6
1432	56.3	75.9	52.0	74.7	53.7	76.5	0.0	1.6	-1.6
1435	-39.9	75.9	52.0	74.8	53.7	76.5	0.0	1.6	-1.6
1439	8.8	75.9	52.0	75.1	53.7	76.6	0.0	1.6	-1.6
1442	30.7	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1446	56.3	75.9	51.9	75.1	53.6	76.6	0.0	1.6	-1.6
1450	-85.4	75.9	51.9	75.0	53.6	76.6	0.0	1.6	-1.6
1453	35.9	75.9	52.0	75.2	53.7	76.6	0.0	1.6	-1.6
1457	17.8	75.9	52.0	75.1	53.7	76.6	0.0	1.6	-1.6
1460	-2.1	75.9	51.9	75.1	53.6	76.5	0.0	1.6	-1.6
1464	44.1	75.9	52.0	75.2	53.7	76.6	0.0	1.6	-1.6
1468	37.9	75.9	51.9	75.0	53.6	76.5	0.0	1.6	-1.6
1471	0.1	75.9	51.9	75.1	53.6	76.6	0.0	1.6	-1.6
1475	67.1	75.9	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
1478	-52.7	75.9	51.8	75.3	53.6	76.6	0.0	1.6	-1.6
1482	44.9	75.9	51.9	75.2	53.7	76.6	0.0	1.6	-1.6
1486	32.5	75.9	52.0	75.0	53.7	76.5	0.0	1.6	-1.6
1489	31.6	75.9	51.9	74.9	53.6	76.6	0.0	1.6	-1.6
1493	-68.1	75.9	52.0	75.2	53.7	76.5	0.0	1.6	-1.6
1496	-102.4	75.9	51.9	75.5	53.6	76.6	0.0	1.6	-1.6
1500	64.5	75.9	51.9	75.5	53.6	76.5	0.0	1.6	-1.6
1504	11.3	75.9	52.0	75.0	53.7	76.5	0.0	1.6	-1.6
1507	-85.1	75.9	51.9	75.1	53.7	76.6	0.0	1.6	-1.6
1511	99.6	75.9	52.0	75.1	53.7	76.6	0.0	1.6	-1.6
1514	-21.4	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1518	-43.5	75.9	51.9	75.4	53.6	76.6	0.0	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H		Initial Drop Time, s:	921
Substance:	WHO Water		Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm		Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min		Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F		Ending Evaporation Time, s:	1396
Target RH:	Ambient %		Ending Total Mass, µg:	-7.4
Initial # of Drops:		100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:		97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:		1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1522	-94.0	75.9	52.0	75.7	52.0	76.6	0.0	1.6	-1.6
1525	-59.8	75.9	52.0	75.8	52.0	76.6	0.0	1.6	-1.6
1529	-64.1	75.9	52.0	75.8	52.0	76.6	0.0	1.6	-1.6
1532	11.0	75.9	52.0	75.6	52.0	76.6	0.0	1.6	-1.6
1536	-70.3	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6
1540	-40.6	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6
1543	15.7	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6
1547	-70.5	75.9	51.9	75.9	51.9	76.6	0.0	1.6	-1.6
1550	-44.9	75.9	51.8	75.8	51.8	76.6	0.0	1.6	-1.6
1554	37.7	75.9	51.9	75.7	51.9	76.6	0.0	1.6	-1.6
1558	-12.4	75.9	51.9	75.6	51.9	76.5	0.0	1.6	-1.6
1561	-35.3	75.9	51.9	75.8	51.9	76.6	0.0	1.6	-1.6
1565	-19.0	75.9	52.0	75.7	52.0	76.6	0.0	1.6	-1.6
1568	1.3	75.9	51.9	75.4	53.6	76.5	0.0	1.6	-1.6
1572	26.7	75.9	51.8	75.5	53.6	76.6	0.0	1.6	-1.6
1576	59.0	75.9	51.9	75.3	53.6	76.6	0.0	1.6	-1.6
1579	15.4	75.9	51.9	75.1	53.6	76.6	0.0	1.6	-1.6
1583	-11.3	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
1586	-1.9	75.9	51.9	75.5	51.9	76.6	0.0	1.6	-1.6
1590	0.1	75.9	51.8	75.4	53.6	76.6	0.0	1.6	-1.6
1594	12.3	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1597	-60.4	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1601	35.0	75.9	52.0	75.3	53.7	76.6	0.0	1.6	-1.6
1604	6.1	75.9	51.9	75.1	53.6	76.6	0.0	1.6	-1.6
1608	-17.5	75.9	51.8	75.2	53.6	76.6	0.0	1.6	-1.6
1612	30.9	75.9	52.0	75.4	53.7	76.6	0.0	1.6	-1.6
1615	-49.9	75.9	51.9	75.3	53.6	76.5	0.0	1.6	-1.6
1619	-17.4	75.9	52.0	75.4	53.7	76.6	0.0	1.6	-1.6
1623	43.3	75.9	51.9	75.3	53.6	76.6	0.0	1.6	-1.6
1627	10.6	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6
1631	-54.9	75.9	51.9	75.5	51.9	76.6	0.0	1.6	-1.6
1635	-19.8	75.9	52.0	75.5	53.7	76.5	0.0	1.6	-1.6
1638	-44.5	75.9	51.9	75.5	51.9	76.6	0.0	1.6	-1.6
1642	10.7	75.9	52.0	75.6	52.0	76.6	0.0	1.6	-1.6
1645	43.8	75.9	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
1649	30.5	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1653	67.4	75.9	51.9	75.0	53.6	76.6	0.0	1.6	-1.6
1656	-32.3	75.9	52.0	75.0	53.7	76.5	0.0	1.6	-1.6
1660	42.0	75.9	51.9	75.2	53.6	76.5	0.0	1.6	-1.6
1663	4.3	75.9	52.0	75.2	53.7	76.6	0.0	1.6	-1.6
1667	-52.3	75.9	51.9	75.5	51.9	76.6	0.0	1.6	-1.6
1671	-30.7	75.9	52.0	75.7	52.0	76.6	0.0	1.6	-1.6
1674	63.9	75.9	52.0	75.6	52.0	76.6	0.0	1.6	-1.6
1678	15.3	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1681	-9.0	75.9	51.9	75.2	53.6	76.6	0.0	1.6	-1.6
1685	-86.0	75.9	52.0	75.4	53.7	76.6	0.0	1.6	-1.6
1689	11.7	75.9	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
1692	3.4	75.9	52.0	75.5	53.7	76.6	0.0	1.6	-1.6
1696	-32.4	75.9	52.0	75.4	53.7	76.5	0.0	1.6	-1.6
1699	-43.1	75.9	51.9	75.5	51.9	76.5	0.0	1.6	-1.6
1703	-6.1	75.9	51.9	75.7	51.9	76.6	0.0	1.6	-1.6
1707	-16.8	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6
1710	-27.7	75.9	51.9	75.6	51.9	76.6	0.0	1.6	-1.6

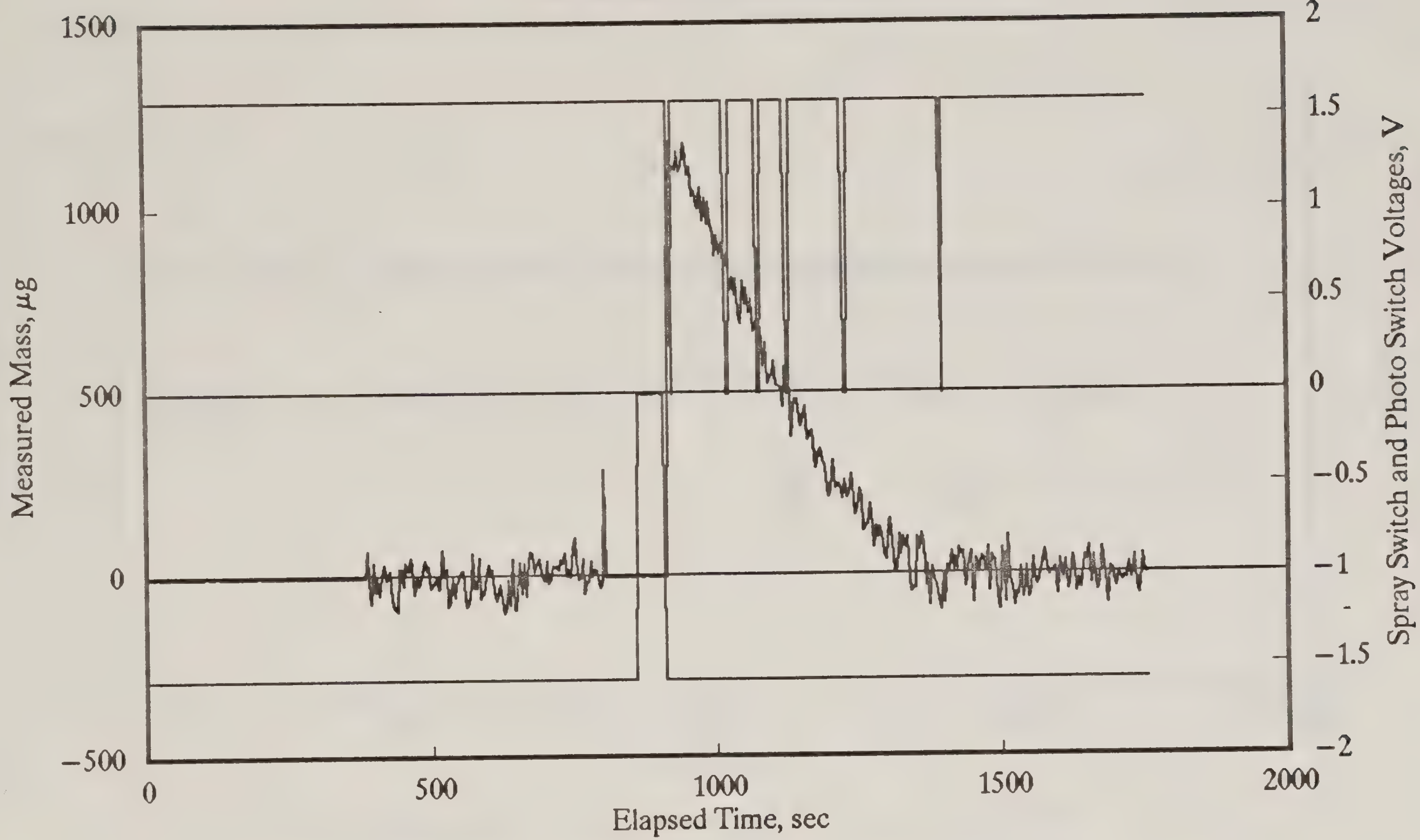
Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392H	Initial Drop Time, s:	921
Substance:	WHO Water	Initial Total Mass, µg:	1093.1
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	10.93
Target Air Velocity:	0 ft/min	Average Initial Drop Size, µm:	293
Target Temperature:	Ambient °F	Ending Evaporation Time, s:	1396
Target RH:	Ambient %	Ending Total Mass, µg:	-7.4
Initial # of Drops:	100	Overall Evaporation Period, s:	475
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	1100.5
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	23.2

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1714	-12.8	75.9	51.9	75.4	53.6	76.6	0.0	1.6	-1.6
1717	-19.3	75.9	51.9	75.7	51.9	76.6	0.0	1.6	-1.6
1721	23.6	75.9	51.8	75.4	53.6	76.6	0.0	1.6	-1.6
1725	-19.3	75.9	51.9	75.3	53.6	76.6	0.0	1.6	-1.6
1728	-3.8	75.9	51.8	75.4	53.5	76.6	0.0	1.6	-1.6
1732	43.2	75.9	51.9	75.4	53.7	76.6	0.0	1.6	-1.6
1735	-38.0	75.9	52.0	75.6	52.0	76.6	0.0	1.6	-1.6
1739	-62.6	75.9	51.9	75.8	51.9	76.5	0.0	1.6	-1.6
1743	3.5	75.9	52.0	75.7	52.0	76.5	0.0	1.6	-1.6
1746	46.0	75.9	51.9	75.5	51.9	76.6	0.0	1.6	-1.6
1750	-5.9	75.9	52.0	75.4	53.7	76.7	0.0	1.6	-1.6
1753	-6.1	75.9	52.0	75.2	53.7	76.6	0.0	1.6	-1.6
	Averages:	75.9	52.2	75.1	53.7	76.5	0.0		

Test Number: 110392H

Test Substance: WHO Water

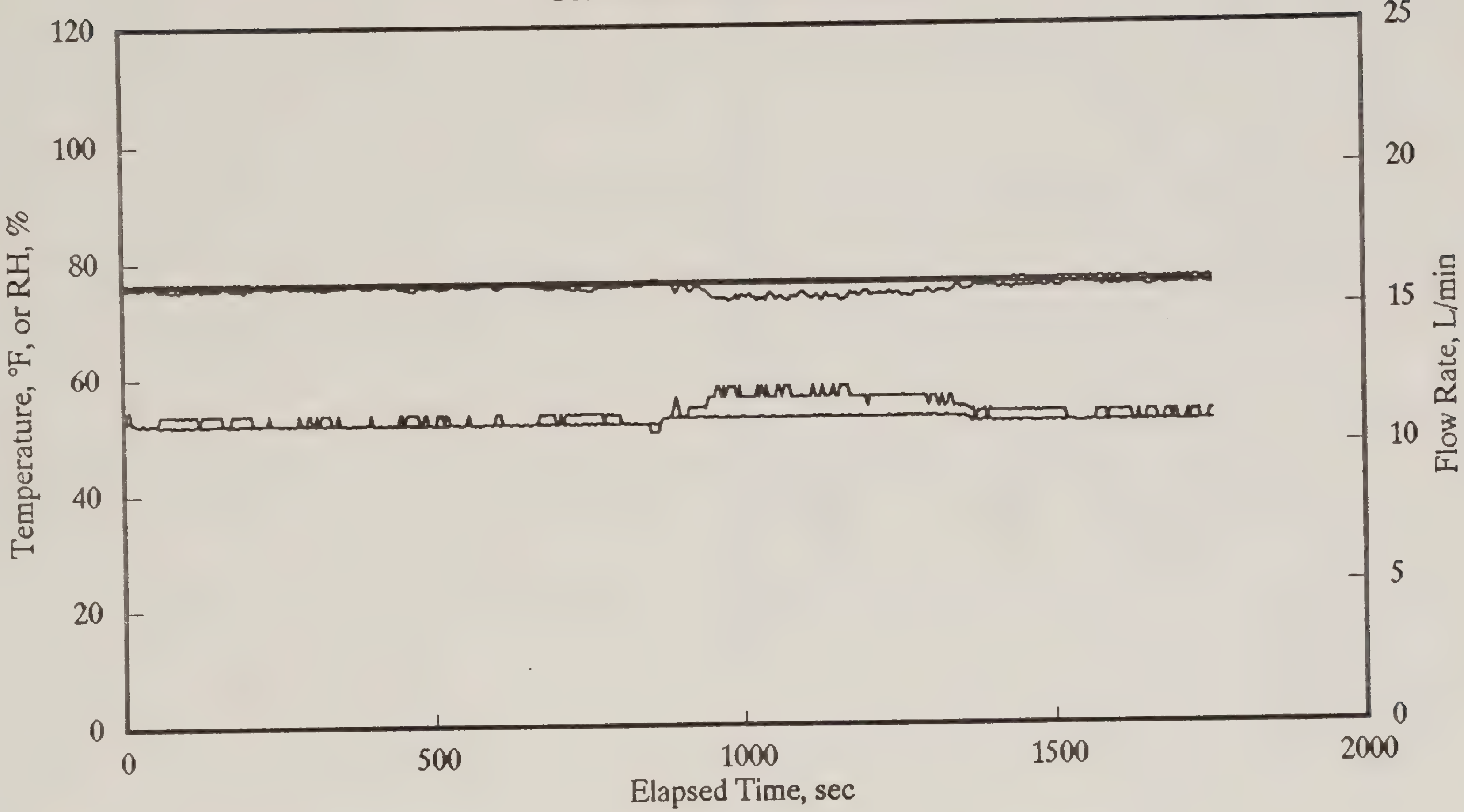


—— Mass —— Spray —— Photo

Target Drop Size: 400 μm; Target Air Velocity: 0 ft/min.
Target Drop Temperature: Ambient °F; Target Drop RH: Ambient %.

Test Number: 110392H

Test Substance: WHO Water



____ Meter Temp. ____ Meter RH ____ Drop Temp.

____ Drop RH ____ Balance Temp. ____ Flow Rate

Target Drop Size: 400 μm; Target Air Velocity: 0 ft/min.
Target Drop Temperature: Ambient °F; Target Drop RH: Ambient %.

APPENDIX C

EXAMPLE OF REDUCED DATA FROM A DROPLET-EVAPORATION TEST WITH AIRFLOW

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
0	-5.6	51.5	74.7	58.3	60.7	75.5	15.4	1.6	-1.6
4	-5.9	51.5	73.9	58.4	60.1	75.5	15.5	1.6	-1.6
7	-6.2	51.5	73.9	58.5	58.1	75.5	15.4	1.6	-1.6
11	-7.1	51.5	73.8	58.5	60.0	75.4	15.4	1.6	-1.6
20	-6.0	51.5	73.7	59.0	58.0	75.4	15.4	1.6	-1.6
23	-6.5	51.5	73.7	58.1	59.9	75.5	15.4	1.6	-1.6
27	-5.8	51.5	73.7	58.4	60.0	75.5	15.3	1.6	-1.6
30	-6.3	51.5	73.7	59.1	58.0	75.6	15.4	1.6	-1.6
34	-6.5	51.5	73.7	58.8	58.0	75.5	15.4	1.6	-1.6
37	-6.6	51.5	73.7	59.0	58.0	75.5	15.4	1.6	-1.6
41	-6.6	51.5	73.7	58.9	58.0	75.5	15.4	1.6	-1.6
44	-5.9	51.5	73.7	59.4	58.0	75.6	15.4	1.6	-1.6
48	-6.6	51.5	73.7	58.7	58.0	75.5	15.4	1.6	-1.6
51	-6.5	51.5	73.7	58.9	58.0	75.5	15.4	1.6	-1.6
55	-5.5	51.5	73.7	58.5	58.0	75.5	15.5	1.6	-1.6
58	-6.7	51.5	73.8	58.5	58.0	75.4	15.5	1.6	-1.6
62	-6.5	51.5	73.8	58.4	60.0	75.5	15.5	1.6	-1.6
65	-6.6	51.5	73.7	58.6	58.0	75.4	15.4	1.6	-1.6
68	-7.9	51.5	73.7	58.4	59.9	75.4	15.4	1.6	-1.6
72	-6.9	51.5	73.7	58.6	58.0	75.5	15.5	1.6	-1.6
75	-7.3	51.5	73.7	58.6	58.0	75.5	15.3	1.6	-1.6
79	-6.7	51.5	73.7	58.4	60.0	75.5	15.4	1.6	-1.6
82	-6.5	51.5	73.8	59.0	58.0	75.5	15.4	1.6	-1.6
86	-5.6	51.5	73.8	58.7	58.0	75.5	15.3	1.6	-1.6
89	-6.1	51.5	73.7	59.3	58.0	75.5	15.4	1.6	-1.6
93	-6.4	51.5	73.7	58.6	58.0	75.5	15.5	1.6	-1.6
96	-6.7	51.5	73.7	58.6	58.0	75.5	15.5	1.6	-1.6
100	-7.1	51.5	73.7	58.6	58.0	75.4	15.5	1.6	-1.6
103	-7.8	51.5	73.7	58.8	58.0	75.5	15.3	1.6	-1.6
107	-6.2	51.5	73.8	59.0	58.0	75.5	15.4	1.6	-1.6
110	-6.9	51.5	73.7	58.8	58.0	75.3	15.4	1.6	-1.6
114	-6.6	51.5	73.7	58.8	58.0	75.5	15.4	1.6	-1.6
117	-5.7	51.5	73.7	58.6	58.0	75.4	15.4	1.6	-1.6
120	-6.2	51.5	73.7	58.8	58.0	75.5	15.4	1.6	-1.6
124	-6.6	51.5	73.7	58.8	58.0	75.5	15.3	1.6	-1.6
127	-6.0	51.5	73.7	58.9	58.0	75.5	15.4	1.6	-1.6
131	-7.2	51.5	73.7	58.6	58.0	75.5	15.5	1.6	-1.6
134	-6.1	51.6	73.7	58.8	58.0	75.5	15.5	1.6	-1.6
138	-6.2	51.5	73.7	58.9	58.0	75.5	15.5	1.6	-1.6
141	-7.4	51.5	73.8	58.5	58.0	75.4	15.4	1.6	-1.6
145	-7.1	51.5	73.7	58.8	58.0	75.4	15.3	1.6	-1.6
148	-7.3	51.5	73.7	59.1	58.0	75.5	15.4	1.6	-1.6
152	-6.6	51.5	73.7	58.8	58.0	75.5	15.4	1.6	-1.6
155	-7.0	51.5	73.8	59.2	58.0	75.5	15.4	1.6	-1.6
159	-6.3	51.5	73.8	58.6	58.0	75.5	15.3	1.6	-1.6
162	-7.2	51.5	73.7	58.9	58.0	75.5	15.5	1.6	-1.6
165	-7.5	51.5	73.7	58.9	58.0	75.5	15.4	1.6	-1.6
169	-7.2	51.5	73.7	59.3	58.0	75.5	15.5	1.6	-1.6
172	-5.9	51.5	73.8	59.0	58.0	75.6	15.4	1.6	-1.6
176	-7.3	51.5	73.8	58.5	60.0	75.5	15.4	1.6	-1.6
179	-7.2	51.5	73.7	59.0	58.0	75.5	15.4	1.6	-1.6
183	-6.3	51.5	73.7	58.7	58.0	75.5	15.4	1.6	-1.6
186	-5.4	51.5	73.7	58.8	58.0	75.5	15.3	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
190	-8.1	51.5	73.7	59.0	58.0	75.5	15.5	1.6	-1.6
193	-7.3	51.5	73.7	59.1	58.0	75.5	15.4	1.6	-1.6
197	-7.0	51.5	73.7	59.2	58.0	75.5	15.5	1.6	-1.6
200	-6.9	51.5	73.7	59.4	58.0	75.5	15.4	1.6	-1.6
204	-7.6	51.5	73.7	59.3	58.0	75.5	15.4	1.6	-1.6
207	-5.2	51.5	73.7	58.8	58.0	75.5	15.4	1.6	-1.6
210	-7.4	51.6	73.7	59.0	58.0	75.4	15.4	1.6	-1.6
214	-7.3	51.5	73.7	58.7	58.0	75.5	15.4	1.6	-1.6
217	-7.1	51.5	73.7	58.9	58.0	75.5	15.5	1.6	-1.6
221	-7.8	51.5	73.7	58.9	58.0	75.5	15.4	1.6	-1.6
225	-7.0	51.6	73.5	59.0	57.9	75.4	15.4	1.6	-1.6
229	-7.0	51.5	72.7	58.9	57.2	75.5	15.4	1.6	-1.6
232	-6.9	51.5	72.7	58.9	57.2	75.5	15.4	1.6	-1.6
236	-6.3	51.5	72.8	58.9	57.2	75.4	15.4	1.6	-1.6
239	-6.4	51.5	72.7	59.0	57.2	75.5	15.5	1.6	-1.6
243	-6.0	51.5	72.7	58.8	57.2	75.5	15.4	1.6	-1.6
246	-7.0	51.5	72.7	58.9	57.2	75.5	15.4	1.6	-1.6
250	-6.1	51.5	72.7	59.0	57.2	75.5	15.5	1.6	-1.6
253	-5.9	51.5	72.7	58.5	57.2	75.5	15.4	1.6	-1.6
257	-6.4	51.5	72.7	58.7	57.2	75.5	15.4	1.6	-1.6
260	-6.8	51.5	72.7	59.1	57.2	75.5	15.4	1.6	-1.6
264	-7.0	51.5	72.7	59.0	57.2	75.5	15.5	1.6	-1.6
267	-7.3	51.5	72.7	58.7	57.2	75.4	15.4	1.6	-1.6
270	-6.3	51.5	72.8	59.0	57.3	75.4	15.4	1.6	-1.6
274	-7.3	51.5	72.8	58.9	57.3	75.5	15.4	1.6	-1.6
277	-7.5	51.5	72.7	59.1	57.2	75.5	15.4	1.6	-1.6
281	-7.0	51.5	72.7	58.7	57.2	75.5	15.4	1.6	-1.6
284	-7.6	51.5	71.8	58.9	56.5	75.5	15.5	1.6	-1.6
288	-6.5	51.5	71.8	59.6	54.6	75.5	15.4	1.6	-1.6
291	-7.4	51.5	71.7	59.2	56.4	75.5	15.5	1.6	-1.6
295	-6.8	51.5	71.8	59.1	56.5	75.5	15.4	1.6	-1.6
298	-7.9	51.5	71.7	59.2	56.4	75.4	15.3	1.6	-1.6
302	-6.6	51.5	71.8	59.1	56.5	75.5	15.4	1.6	-1.6
305	-6.6	51.5	71.8	59.4	56.5	75.5	15.4	1.6	-1.6
309	-7.2	51.5	71.8	59.5	56.5	75.5	15.5	1.6	-1.6
312	-6.2	51.5	71.7	58.7	56.4	75.4	15.4	1.6	-1.6
315	-7.1	51.5	71.7	59.2	56.4	75.4	15.3	1.6	-1.6
319	-5.8	51.5	71.7	59.2	56.4	75.5	15.4	1.6	-1.6
322	-6.9	51.5	71.8	58.6	56.5	75.5	15.4	1.6	-1.6
326	-6.2	51.5	71.7	59.3	56.4	75.5	15.5	1.6	-1.6
329	-6.1	51.5	71.7	58.9	56.4	75.5	15.4	1.6	-1.6
333	-7.1	51.5	71.7	58.9	56.4	75.5	15.4	1.6	-1.6
336	-6.4	51.5	71.8	59.0	56.5	75.5	15.5	1.6	-1.6
340	-7.8	51.5	71.8	58.7	56.5	75.5	15.5	1.6	-1.6
343	-6.7	51.5	71.8	59.0	56.5	75.5	15.5	1.6	-1.6
347	-6.4	51.5	71.7	59.2	56.4	75.5	15.4	1.6	-1.6
350	-6.6	51.5	71.4	58.8	56.2	75.5	15.5	1.6	-1.6
354	-6.3	51.5	70.8	58.9	55.7	75.5	15.5	1.6	-1.6
357	-7.2	51.5	70.8	59.0	55.7	75.5	15.4	1.6	-1.6
361	-6.4	51.5	70.7	58.8	55.7	75.5	15.5	1.6	-1.6
364	-7.1	51.5	70.7	59.0	55.6	75.5	15.3	1.6	-1.6
367	-7.9	51.5	70.8	59.0	55.7	75.4	15.3	1.6	-1.6
371	-7.1	51.5	70.8	58.8	55.7	75.5	15.4	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
374	-6.5	51.5	70.7	58.5	55.6	75.5	15.4	1.6	-1.6
378	-6.9	51.5	70.7	58.6	55.7	75.4	15.5	1.6	-1.6
381	-6.5	51.5	70.7	58.8	55.6	75.5	15.3	1.6	-1.6
385	-7.5	51.5	70.7	59.7	53.8	75.5	15.3	1.6	-1.6
388	-6.4	51.5	70.8	67.0	42.6	75.5	15.4	1.6	-1.6
392	-118.3	51.6	70.8	69.3	39.9	75.5	15.4	1.6	-1.6
395	-116.2	51.6	70.7	71.2	37.4	75.6	15.3	1.6	-1.6
399	-59.4	51.6	70.7	71.9	36.3	75.5	15.4	1.6	-1.6
402	-42.1	51.6	70.7	71.2	37.4	75.6	15.3	1.6	-1.6
406	-63.6	51.6	70.7	71.8	36.2	75.6	15.3	1.6	-1.6
409	42.3	51.6	70.8	71.7	36.3	75.6	15.3	1.6	-1.6
412	36.7	51.6	70.8	71.4	37.4	75.6	15.3	1.6	-1.6
416	53.7	51.6	70.8	71.4	37.4	75.6	15.3	1.6	-1.6
419	68.3	51.6	70.7	71.5	37.4	75.7	15.3	1.6	-1.6
423	38.3	51.6	70.7	71.6	36.2	75.7	15.3	1.6	-1.6
426	-19.3	51.6	70.7	71.7	36.2	75.7	15.3	1.6	-1.6
430	68.5	51.6	70.8	72.0	36.3	75.7	15.4	1.6	-1.6
433	45.4	51.6	70.7	71.9	36.2	75.7	15.2	1.6	-1.6
437	14.7	51.6	70.8	71.9	36.3	75.7	15.4	1.6	-1.6
440	28.2	51.6	70.7	72.0	36.3	75.7	15.4	1.6	-1.6
444	24.3	51.6	70.7	72.0	36.2	75.7	15.3	1.6	-1.6
447	20.5	51.6	70.8	72.4	36.3	75.7	15.3	1.6	-1.6
452	65.4	51.6	70.8	72.5	35.1	75.7	15.4	1.6	-1.6
455	8.2	51.6	70.7	72.7	35.1	75.7	15.4	1.6	-1.6
459	-58.3	51.6	70.7	72.9	35.1	75.8	15.3	1.6	-1.6
462	-1.5	51.6	70.8	72.9	35.1	75.8	15.3	1.6	-1.6
466	27.5	51.6	70.8	72.9	35.1	75.7	15.4	1.6	-1.6
469	54.6	51.6	70.7	72.7	35.1	75.7	15.3	1.6	-1.6
472	15.6	51.6	70.7	72.7	35.1	75.7	15.4	1.6	-1.6
476	42.9	51.6	70.7	72.8	35.1	75.7	15.3	1.6	-1.6
479	35.7	51.6	70.7	72.8	35.1	75.7	15.2	1.6	-1.6
483	17.9	51.6	70.7	73.0	35.1	75.7	15.3	1.6	-1.6
486	-2.1	51.6	70.8	73.0	35.1	75.7	15.4	1.6	-1.6
490	29.9	51.6	70.7	73.3	35.1	75.7	15.3	1.6	-1.6
493	44.3	51.6	70.7	73.3	35.1	75.7	15.3	1.6	-1.6
497	61.5	51.6	70.8	73.2	35.1	75.7	15.4	1.6	-1.6
500	41.2	51.6	70.7	73.0	35.1	75.7	15.3	1.6	-1.6
504	-2.5	51.6	70.8	73.1	35.1	75.7	15.3	1.6	-1.6
507	62.3	51.6	70.7	73.1	35.1	75.7	15.3	1.6	-1.6
511	55.8	51.6	70.8	73.0	35.1	75.7	15.4	1.6	-1.6
514	34.2	51.6	70.7	73.0	35.1	75.7	15.3	1.6	-1.6
517	-41.4	51.6	70.7	73.1	35.1	75.7	15.3	1.6	-1.6
521	-38.5	51.6	70.7	73.6	34.0	75.7	15.3	1.6	-1.6
524	-6.9	51.6	70.7	73.7	34.0	75.7	15.3	1.6	-1.6
528	5.5	51.6	70.8	73.6	34.0	75.7	15.4	1.6	-1.6
531	26.9	51.6	70.7	73.5	35.1	75.7	15.3	1.6	-1.6
535	38.5	51.6	70.7	73.1	35.1	75.7	15.3	1.6	-1.6
538	-34.1	51.6	70.8	73.2	35.1	75.7	15.4	1.6	-1.6
542	-28.0	51.6	70.8	73.8	34.0	75.7	15.3	1.6	-1.6
545	8.2	51.6	70.7	73.6	34.0	75.7	15.4	1.6	-1.6
549	27.7	51.6	70.7	73.6	34.0	75.7	15.3	1.6	-1.6
552	49.3	51.6	70.7	73.5	35.1	75.8	15.3	1.6	-1.6
556	63.3	51.6	70.8	73.4	35.1	75.7	15.3	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
559	21.8	51.6	70.7	73.3	35.1	75.7	15.3	1.6	-1.6
563	42.8	51.6	70.7	73.3	35.1	75.8	15.4	1.6	-1.6
566	-35.4	51.6	70.7	73.2	35.1	75.7	15.3	1.6	-1.6
569	-68.8	51.6	70.8	73.7	34.0	75.7	15.4	1.6	-1.6
573	-2.5	51.6	70.7	73.9	34.0	75.7	15.3	1.6	-1.6
576	21.6	51.6	70.8	73.5	34.0	75.7	15.3	1.6	-1.6
580	46.9	51.6	70.7	73.4	35.1	75.7	15.3	1.6	-1.6
583	-9.8	51.6	70.7	73.7	34.0	75.7	15.3	1.6	-1.6
587	35.8	51.6	70.7	73.6	34.0	75.6	15.4	1.6	-1.6
590	-11.6	51.6	70.7	73.5	34.0	75.7	15.4	1.6	-1.6
594	-23.2	51.6	70.7	73.8	34.0	75.7	15.3	1.6	-1.6
597	-33.8	51.5	70.8	73.7	34.0	75.7	15.3	1.6	-1.6
601	-4.4	51.5	70.7	73.9	34.0	75.7	15.3	1.6	-1.6
604	-13.7	51.6	70.7	73.6	34.0	75.7	15.3	1.6	-1.6
608	0.6	51.5	70.7	73.4	35.1	75.7	15.3	1.6	-1.6
611	8.9	51.6	70.7	73.4	35.1	75.8	15.3	1.6	-1.6
615	-9.7	51.5	70.7	73.6	34.0	75.7	15.4	1.6	-1.6
618	14.8	51.6	70.8	73.6	34.0	75.7	15.3	1.6	-1.6
621	34.6	51.5	70.8	73.7	34.0	75.7	15.3	1.6	-1.6
625	-36.6	51.6	70.8	73.8	34.0	75.7	15.3	1.6	-1.6
628	-46.2	51.5	70.8	74.0	34.0	75.7	15.3	1.6	-1.6
632	36.4	51.5	70.8	74.0	34.0	75.7	15.3	1.6	-1.6
635	0.7	51.5	70.7	73.9	34.0	75.7	15.2	1.6	-1.6
639	-49.9	51.5	70.7	73.9	34.0	75.7	15.4	1.6	-1.6
642	-22.3	51.5	70.7	73.9	34.0	75.8	15.3	1.6	-1.6
646	56.1	51.5	70.8	73.7	34.0	75.7	15.3	1.6	-1.6
649	-10.6	51.5	70.8	73.7	34.0	75.7	15.3	1.6	-1.6
653	-5.9	51.5	70.7	73.7	34.0	75.7	15.2	1.6	-1.6
656	-13.0	51.5	70.8	73.7	34.0	75.7	15.3	1.6	-1.6
660	-34.4	51.5	70.7	73.9	34.0	75.7	15.4	1.6	-1.6
663	17.6	51.5	70.8	74.0	34.0	75.7	15.3	1.6	-1.6
666	1.6	51.5	70.8	73.9	34.0	75.8	15.3	1.6	-1.6
670	6.6	51.5	70.7	73.8	34.0	75.7	15.3	1.6	-1.6
673	2.1	51.5	70.6	74.1	33.9	75.8	15.3	1.6	-1.6
678	45.7	51.5	70.3	73.9	33.8	75.7	15.2	1.6	-1.6
681	13.4	51.5	70.7	73.5	34.0	75.6	15.3	1.6	-1.6
685	31.6	51.5	70.7	73.6	34.0	75.7	15.4	1.6	-1.6
688	11.3	51.5	70.7	73.8	34.0	75.7	15.2	1.6	-1.6
692	-30.1	51.5	70.8	73.9	34.0	75.7	15.3	1.6	-1.6
695	2.1	51.5	70.7	74.1	34.0	75.7	15.4	1.6	-1.6
699	1.2	51.5	70.8	73.9	34.0	75.6	15.4	1.6	-1.6
702	24.4	51.5	70.7	73.8	34.0	75.7	15.2	1.6	-1.6
706	57.6	51.5	70.7	73.8	34.0	75.7	15.2	1.6	-1.6
709	47.2	51.5	70.0	73.6	33.6	75.7	15.3	1.6	-1.6
713	37.8	51.5	69.9	73.7	33.6	75.7	15.2	1.6	-1.6
716	36.7	51.5	70.1	73.6	33.7	75.6	15.3	1.6	-1.6
720	14.7	51.5	69.7	73.4	34.6	75.7	15.3	1.6	-1.6
723	26.1	51.5	69.8	73.5	33.5	75.7	15.3	1.6	-1.6
726	-31.6	51.5	69.8	74.1	33.5	75.7	15.4	1.6	-1.6
730	35.4	51.5	69.8	74.1	33.5	75.7	15.4	1.6	-1.6
733	26.3	51.5	69.8	73.9	33.6	75.7	15.3	1.6	-1.6
737	-24.5	51.5	69.7	73.7	33.5	75.7	15.3	1.6	-1.6
740	-0.5	51.5	69.8	73.6	33.5	75.7	15.3	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
744	-14.4	51.5	69.7	73.8	33.5	75.7	15.3	1.6	-1.6
747	1.1	51.5	69.7	73.8	33.5	75.7	15.3	1.6	-1.6
751	15.9	51.5	69.8	73.7	33.5	75.7	15.3	1.6	-1.6
754	33.9	51.5	69.7	73.9	33.5	75.7	15.3	1.6	-1.6
758	-41.3	51.5	69.7	73.8	33.5	75.7	15.3	1.6	-1.6
761	3.5	51.5	69.7	73.8	33.5	75.7	15.2	1.6	-1.6
765	66.9	51.5	69.7	73.7	33.5	75.7	15.4	1.6	-1.6
768	59.5	51.5	69.8	73.7	33.5	75.7	15.3	1.6	-1.6
772	12.9	51.5	69.8	73.6	33.5	75.7	15.3	1.6	-1.6
775	1.3	51.5	69.8	73.8	33.5	75.7	15.4	1.6	-1.6
778	27.6	51.5	69.7	73.9	33.5	75.8	15.3	1.6	-1.6
782	44.3	51.5	69.8	73.6	33.5	75.7	15.3	1.6	-1.6
785	27.3	51.5	69.7	73.5	33.5	75.7	15.4	1.6	-1.6
789	22.5	51.5	69.8	73.6	33.6	75.7	15.4	1.6	-1.6
792	-9.3	51.5	69.8	73.7	33.5	75.7	15.3	1.6	-1.6
796	50.2	51.5	69.8	73.9	33.5	75.7	15.3	1.6	-1.6
799	34.2	51.5	69.8	73.6	33.5	75.7	15.4	1.6	-1.6
803	-15.7	51.5	69.8	73.6	33.5	75.7	15.4	1.6	-1.6
806	52.8	51.5	69.7	73.5	33.5	75.7	15.3	1.6	-1.6
810	32.4	51.5	69.7	73.4	34.6	75.7	15.3	1.6	-1.6
813	24.4	51.5	69.8	73.5	33.6	75.7	15.4	1.6	-1.6
817	6.9	51.5	69.8	73.7	33.5	75.7	15.4	1.6	-1.6
820	36.6	51.5	69.7	73.5	33.5	75.8	15.3	1.6	-1.6
823	-49.1	51.5	69.7	73.7	33.5	75.8	15.3	1.6	-1.6
827	-4.6	51.5	69.7	73.7	33.5	75.7	15.3	1.6	-1.6
830	11.7	51.5	69.8	73.6	33.6	75.8	15.3	1.6	-1.6
834	-20.9	51.5	69.8	73.7	33.5	75.8	15.4	1.6	-1.6
837	0.3	51.5	69.7	73.7	33.5	75.7	15.3	1.6	-1.6
841	-37.6	51.5	69.8	74.0	33.6	75.7	15.3	1.6	-1.6
844	39.1	51.5	69.7	73.9	33.5	75.7	15.2	1.6	-1.6
848	-5.0	51.5	69.7	73.9	33.5	75.7	15.3	1.6	-1.6
851	-16.7	51.5	69.8	73.8	33.6	75.7	15.4	1.6	-1.6
855	-12.4	51.5	69.8	73.7	33.6	75.7	15.3	1.6	-1.6
858	-55.5	51.5	69.8	73.8	33.6	75.7	15.3	1.6	-1.6
862	12.8	51.5	69.8	73.9	33.5	75.8	15.4	1.6	-1.6
865	13.8	51.5	69.7	73.7	33.5	75.7	15.2	1.6	-1.6
868	4.7	51.5	69.7	73.7	33.5	75.7	15.3	1.6	-1.6
872	31.1	51.5	69.8	73.7	33.6	75.7	15.4	1.6	-1.6
875	41.8	51.5	69.8	73.6	33.5	75.7	15.3	1.6	-1.6
879	2.0	51.5	69.7	73.5	34.6	75.7	15.3	1.6	-1.6
882	22.7	51.5	69.8	73.5	34.6	75.7	15.4	1.6	-1.6
886	83.8	51.5	69.8	73.5	34.6	75.7	15.4	1.6	-1.6
889	-28.4	51.5	69.7	73.5	34.6	75.7	15.4	1.6	-1.6
893	-4.0	51.5	69.7	73.6	33.5	75.7	15.5	1.6	-1.6
896	48.7	51.5	69.8	73.6	33.5	75.7	15.3	1.6	-1.6
900	57.2	51.5	69.7	73.5	34.6	75.7	15.3	1.6	-1.6
904	40.3	51.5	69.7	73.6	33.5	75.8	15.2	1.6	-1.6
908	-0.4	51.5	69.8	73.7	33.5	75.8	15.4	1.6	-1.6
911	20669.2	51.5	69.8	64.5	46.4	75.8	15.3	1.6	-1.6
915	22032.6	51.5	69.8	58.0	56.8	75.7	15.4	1.6	-1.6
918	21899.2	51.5	69.8	57.0	58.7	75.7	15.3	1.6	-1.6
922	21054.1	51.5	69.8	57.7	56.8	75.7	15.4	1.6	-1.6
925	21232.8	51.5	69.7	57.0	58.6	75.6	15.4	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number: 110392F
Substance: WHO Water
Target Drop Size: 400 μm
Target Air Velocity: 300 ft/min
Target Temperature: 59 °F
Target RH: 60 %
Initial # of Drops: 106
Average DSD Fiber Diameter in μm: 97.3
Test-Substance Density in g/mL: 1.00

Initial Drop Time, s: 1433
Initial Total Mass, μg: 1273.5
Average Initial Drop Mass, μg: 12.01
Average Initial Drop Size, μm: 301
Ending Evaporation Time, s: 1497
Ending Total Mass, μg: 294.2
Overall Evaporation Period, s: 64
Total Mass Loss, μg: 979.4
Overall Evap. Rate, ng/s: 144.4

Elapsed Time, sec	Microbalance Mass, μg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
929	20979.0	51.5	69.7	57.5	58.7	75.6	15.4	1.6	-1.6
932	21234.4	51.5	69.8	56.9	58.7	75.5	15.5	1.6	-1.6
935	21244.4	51.5	69.7	57.2	58.6	75.6	15.3	1.6	-1.6
939	21193.1	51.5	69.7	57.2	58.6	75.5	15.3	1.6	-1.6
942	20445.6	51.5	69.8	57.2	58.7	75.5	15.4	1.6	-1.6
946	20672.1	51.5	69.8	57.3	58.7	75.7	15.5	1.6	-1.6
949	21304.8	51.5	69.7	57.1	58.7	75.5	15.4	1.6	-1.6
953	21102.1	51.5	69.7	56.5	58.6	75.5	15.3	1.6	-1.6
956	20998.5	51.5	69.7	57.1	58.7	75.5	15.3	1.6	-1.6
960	21114.6	51.5	69.8	57.1	56.7	75.6	15.4	1.6	-1.6
963	21536.2	51.5	69.7	56.8	58.6	75.6	15.3	1.6	-1.6
967	21056.3	51.5	69.7	56.9	58.7	75.6	15.3	1.6	-1.6
970	21085.9	51.5	69.7	57.1	58.7	75.6	15.4	1.6	-1.6
974	21160.9	51.5	69.7	57.0	58.6	75.6	15.4	1.6	-1.6
977	21183.1	51.5	69.8	57.2	58.7	75.6	15.3	1.6	-1.6
980	21029.0	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
984	20929.2	51.5	69.8	57.2	58.7	75.5	15.4	1.6	-1.6
987	21100.0	51.5	69.7	57.4	58.6	75.6	15.4	1.6	-1.6
991	21076.0	51.5	69.7	56.8	58.6	75.6	15.4	1.6	-1.6
994	21299.1	51.5	69.7	57.4	58.7	75.6	15.3	1.6	-1.6
998	21056.7	51.5	69.7	57.2	58.7	75.5	15.3	1.6	-1.6
1001	21079.6	51.5	69.8	56.8	58.7	75.6	15.5	1.6	-1.6
1005	21251.2	51.5	69.8	57.0	58.7	75.7	15.4	1.6	-1.6
1008	21052.4	51.5	69.7	56.9	58.6	75.6	15.3	1.6	-1.6
1012	21116.2	51.5	69.8	57.3	58.7	75.5	15.4	1.6	-1.6
1015	21087.5	51.5	69.7	57.1	58.7	75.6	15.4	1.6	-1.6
1019	21334.6	51.5	69.7	56.9	58.7	75.6	15.4	1.6	-1.6
1022	21079.1	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
1026	21016.9	51.5	69.8	57.4	58.7	75.5	15.4	1.6	-1.6
1029	21112.2	51.5	69.7	57.0	58.7	75.6	15.4	1.6	-1.6
1032	21186.1	51.5	69.7	56.9	58.7	75.5	15.4	1.6	-1.6
1036	21237.2	51.5	69.8	57.5	56.8	75.6	15.4	1.6	-1.6
1039	21249.0	51.5	69.7	57.1	58.6	75.6	15.3	1.6	-1.6
1043	21236.2	51.5	69.7	57.2	58.6	75.7	15.4	1.6	-1.6
1046	21202.5	51.5	69.8	57.0	56.7	75.6	15.3	1.6	-1.6
1050	21228.9	51.5	69.7	57.1	58.6	75.6	15.4	1.6	-1.6
1053	21180.1	51.5	69.8	56.9	58.7	75.5	15.4	1.6	-1.6
1057	21299.2	51.5	69.8	57.0	58.7	75.6	15.5	1.6	-1.6
1060	21020.5	51.5	69.7	57.2	58.7	75.5	15.4	1.6	-1.6
1064	21082.5	51.5	69.7	57.7	56.7	75.6	15.3	1.6	-1.6
1067	21037.0	51.5	69.8	56.9	58.7	75.6	15.4	1.6	-1.6
1071	21178.5	51.5	69.7	57.2	58.6	75.5	15.3	1.6	-1.6
1074	21202.6	51.5	69.8	57.0	58.7	75.6	15.4	1.6	-1.6
1077	20983.3	51.5	69.8	57.4	58.7	75.6	15.4	1.6	-1.6
1081	21432.2	51.5	69.7	56.7	58.6	75.6	15.4	1.6	-1.6
1084	21253.2	51.5	69.7	57.0	58.6	75.7	15.3	1.6	-1.6
1088	21258.6	51.5	69.8	57.5	56.8	75.7	15.4	1.6	-1.6
1091	21044.8	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
1095	21246.6	51.5	69.8	57.0	58.7	75.7	15.4	1.6	-1.6
1098	21177.6	51.5	69.7	57.5	58.7	75.6	15.4	1.6	-1.6
1101	21209.8	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
1105	21218.3	51.5	69.7	57.0	58.6	75.5	15.5	1.6	-1.6
1108	21025.6	51.5	69.7	57.1	58.6	75.5	15.3	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number: 110392F
Substance: WHO Water
Target Drop Size: 400 µm
Target Air Velocity: 300 ft/min
Target Temperature: 59 °F
Target RH: 60 %
Initial # of Drops: 106
Average DSD Fiber Diameter in µm: 97.3
Test-Substance Density in g/mL: 1.00

Initial Drop Time, s: 1433
Initial Total Mass, µg: 1273.5
Average Initial Drop Mass, µg: 12.01
Average Initial Drop Size, µm: 301
Ending Evaporation Time, s: 1497
Ending Total Mass, µg: 294.2
Overall Evaporation Period, s: 64
Total Mass Loss, µg: 979.4
Overall Evap. Rate, ng/s: 144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1112	20981.4	51.5	69.7	57.2	58.7	75.6	15.3	1.6	-1.6
1115	21325.3	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
1119	20937.3	51.5	69.8	57.5	58.7	75.6	15.4	1.6	-1.6
1122	20777.2	51.5	69.7	57.8	56.7	75.6	15.3	1.6	-1.6
1126	20770.8	51.5	69.8	57.3	58.7	75.5	15.4	1.6	-1.6
1130	21223.8	51.5	69.7	57.0	58.7	75.6	15.3	1.6	-1.6
1134	21387.7	51.5	69.7	57.1	58.7	75.5	15.3	1.6	-1.6
1137	21548.2	51.5	69.7	57.3	58.6	75.5	15.3	1.6	-1.6
1140	21128.5	51.5	69.7	57.4	58.6	75.5	15.3	1.6	-1.6
1144	20851.8	51.5	69.7	57.2	58.6	75.5	15.4	1.6	-1.6
1147	21089.8	51.5	69.8	57.2	58.7	75.5	15.4	1.6	-1.6
1151	21211.3	51.5	69.8	57.0	58.7	75.6	15.3	1.6	-1.6
1154	20949.0	51.5	69.7	56.9	58.6	75.5	15.4	1.6	-1.6
1158	21055.1	51.5	69.7	56.7	58.6	75.6	15.5	1.6	-1.6
1161	21080.9	51.5	69.7	57.6	56.7	75.6	15.3	1.6	-1.6
1165	21443.2	51.5	69.7	56.9	58.6	75.5	15.3	1.6	-1.6
1168	21143.4	51.5	69.7	56.6	58.7	75.5	15.5	1.6	-1.6
1172	20900.9	51.5	69.8	57.2	58.7	75.6	15.4	1.6	-1.6
1175	21083.8	51.6	69.7	57.0	58.6	75.5	15.4	1.6	-1.6
1179	21358.3	51.5	69.7	57.0	58.6	75.5	15.3	1.6	-1.6
1182	20769.2	51.5	69.8	57.1	58.7	75.5	15.5	1.6	-1.6
1186	20930.4	51.5	69.7	57.1	58.6	75.6	15.4	1.6	-1.6
1189	21173.3	51.5	69.7	57.1	58.7	75.6	15.4	1.6	-1.6
1192	20996.0	51.6	69.7	56.9	58.6	75.6	15.4	1.6	-1.6
1196	20853.8	51.5	69.7	57.1	58.6	75.5	15.4	1.6	-1.6
1199	21201.5	51.5	69.8	57.1	58.7	75.5	15.3	1.6	-1.6
1203	21271.8	51.5	69.8	57.1	58.7	75.5	15.3	1.6	-1.6
1206	21132.7	51.5	69.8	57.3	58.7	75.6	15.3	1.6	-1.6
1210	21030.3	51.5	69.8	57.0	58.7	75.5	15.5	1.6	-1.6
1213	21027.7	51.5	69.4	57.0	58.4	75.5	15.3	1.6	-1.6
1217	21193.4	51.5	69.3	57.2	58.3	75.5	15.4	1.6	-1.6
1220	21578.0	51.5	69.3	56.6	58.3	75.5	15.4	1.6	-1.6
1224	21052.1	51.5	68.7	56.8	57.8	75.6	15.4	1.6	-1.6
1227	20875.4	51.5	68.7	57.0	57.8	75.6	15.4	1.6	-1.6
1231	20932.1	51.5	68.7	57.7	55.9	75.5	15.5	1.6	-1.6
1234	21076.6	51.5	68.7	56.5	57.8	75.6	15.5	1.6	-1.6
1237	21517.0	51.5	68.7	57.0	57.8	75.5	15.5	1.6	-1.6
1241	21457.0	51.5	68.8	56.7	57.9	75.5	15.3	1.6	-1.6
1244	21303.1	51.5	68.7	56.7	57.8	75.5	15.4	1.6	-1.6
1248	21311.7	51.5	68.7	57.0	57.8	75.5	15.4	1.6	-1.6
1251	21444.0	51.5	68.7	56.9	57.8	75.6	15.5	1.6	-1.6
1255	20671.9	51.5	68.8	57.6	55.9	75.5	15.4	1.6	-1.6
1258	21018.9	51.5	68.7	57.2	57.8	75.6	15.4	1.6	-1.6
1262	21409.5	51.5	68.8	56.9	57.9	75.5	15.5	1.6	-1.6
1265	21242.0	51.5	68.7	56.8	57.8	75.6	15.4	1.6	-1.6
1269	21109.7	51.5	68.7	56.5	57.8	75.6	15.5	1.6	-1.6
1272	21081.6	51.5	68.8	56.8	57.9	75.4	15.4	1.6	-1.6
1276	21262.9	51.5	68.8	56.8	57.9	75.5	15.3	1.6	-1.6
1279	21160.5	51.5	68.7	56.8	57.8	75.5	15.4	1.6	-1.6
1283	20974.0	51.5	68.8	56.9	57.9	75.6	15.4	1.6	-1.6
1286	20806.1	51.6	68.7	57.3	57.8	75.6	15.4	1.6	-1.6
1289	21018.7	51.5	68.7	56.7	57.8	75.5	15.5	1.6	-1.6
1293	21268.5	51.5	68.7	56.7	57.8	75.5	15.5	1.6	-1.6

Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F
Substance:	WHO Water
Target Drop Size:	400 µm
Target Air Velocity:	300 ft/min
Target Temperature:	59 °F
Target RH:	60 %
Initial # of Drops:	106
Average DSD Fiber Diameter in µm:	97.3
Test-Substance Density in g/mL:	1.00

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Overall Evaporation Period, s:	64
Total Mass Loss, µg:	979.4
Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1296	21096.4	51.5	68.8	56.7	57.9	75.5	15.4	1.6	-1.6
1300	21144.4	51.5	68.8	57.2	57.9	75.5	15.4	1.6	-1.6
1303	21256.1	51.5	68.7	57.2	57.8	75.6	15.5	1.6	-1.6
1307	21123.1	51.5	68.8	57.0	57.9	75.6	15.3	1.6	-1.6
1310	21093.5	51.6	68.7	57.1	57.8	75.5	15.4	1.6	-1.6
1314	20979.6	51.5	68.7	57.0	57.8	75.5	15.4	1.6	-1.6
1317	21034.6	51.5	68.8	56.8	57.9	75.5	15.4	1.6	-1.6
1321	20844.3	51.6	68.7	56.9	57.8	75.5	15.4	1.6	-1.6
1329	-6.1	51.5	68.7	57.2	57.8	75.6	15.4	1.6	-1.6
1332	-6.6	51.5	68.8	61.9	48.9	75.6	15.4	1.6	-1.6
1336	-7.7	51.5	68.7	57.2	57.8	75.5	15.3	1.6	-1.6
1339	-7.4	51.5	68.8	57.2	57.9	75.5	15.4	1.6	-1.6
1343	-7.6	51.5	68.7	56.8	57.8	75.5	15.4	1.6	-1.6
1346	-7.2	51.6	68.7	56.7	57.8	75.5	15.5	1.6	-1.6
1350	-6.5	51.5	68.7	57.2	57.8	75.6	15.3	1.6	-1.6
1354	-7.4	51.5	68.7	57.1	57.8	75.5	15.4	1.6	-1.6
1358	-7.2	51.5	68.8	57.0	57.9	75.5	15.4	1.6	-1.6
1362	-7.3	51.5	68.7	58.2	55.9	75.5	15.4	1.6	-1.6
1365	-6.3	51.5	68.8	58.3	56.0	75.6	15.5	1.6	-1.6
1369	-5.1	51.5	68.8	57.7	55.9	75.6	15.3	1.6	-1.6
1372	-6.0	51.5	68.8	57.7	56.0	75.6	15.3	1.6	-1.6
1376	-6.2	51.6	68.8	61.1	50.6	75.5	15.3	1.6	-1.6
1380	-6.6	51.5	68.8	70.7	36.4	75.5	15.3	1.6	-1.6
1383	-6.8	51.6	68.7	73.4	34.1	75.5	15.2	1.6	-1.6
1387	-6.6	51.6	67.7	74.6	31.6	75.6	15.3	1.6	-0.0
1390	-7.6	51.6	67.7	75.2	31.6	75.6	15.4	1.6	-0.0
1394	-5.7	51.6	67.8	75.7	30.6	75.7	15.4	1.6	-0.0
1398	-6.6	51.6	67.8	74.5	31.6	75.7	15.4	1.6	-0.0
1401	-6.8	51.5	67.8	74.8	31.6	75.7	15.3	1.6	-1.6
1405	-6.6	51.6	67.7	73.9	32.6	75.7	15.3	1.6	-1.6
1408	-6.7	51.5	67.8	74.8	31.6	75.7	15.3	1.6	-1.6
1412	-6.5	51.6	68.0	73.9	32.7	75.7	15.4	1.6	-1.6
1415	-6.2	51.6	67.8	73.6	32.6	75.8	15.3	1.6	-1.6
1419	-7.0	51.6	68.5	73.9	32.9	75.7	15.4	1.6	-1.6
1423	-6.1	51.5	67.8	74.6	31.6	75.8	15.4	1.6	-1.6
1426	-6.6	51.6	68.6	73.5	33.0	75.8	15.4	1.6	-1.6
1430	1262.3	51.6	68.7	74.1	33.0	75.7	15.3	1.6	-1.6
1433	1273.5	51.6	68.8	73.1	34.1	75.8	15.3	-0.0	-1.6
1437	1263.5	51.6	68.8	72.2	35.2	75.8	15.3	-0.0	-1.6
1440	1255.7	51.5	68.7	71.3	36.3	75.8	15.3	1.6	-1.6
1444	22519.8	51.5	68.8	63.6	45.7	75.8	15.3	1.6	-1.6
1448	24244.1	51.5	68.5	56.6	57.6	75.8	15.2	1.6	-1.6
1451	23780.6	51.5	68.8	55.8	59.8	75.7	15.4	1.6	-1.6
1455	23751.8	51.5	68.7	56.2	59.7	75.7	15.4	1.6	-1.6
1458	23197.2	51.6	68.7	55.8	59.8	75.7	15.3	1.6	-1.6
1462	23165.4	51.6	68.7	55.6	59.8	75.6	15.4	1.6	-1.6
1465	22903.7	51.5	68.8	55.6	59.8	75.5	15.4	1.6	-1.6
1469	22566.3	51.5	68.7	55.6	59.8	75.6	15.5	1.6	-1.6
1472	22494.5	51.5	68.8	55.4	61.9	75.6	15.4	1.6	-1.6
1476	21881.0	51.5	68.8	56.5	59.8	75.5	15.3	1.6	-1.6
1480	22274.7	51.5	68.7	55.5	59.7	75.6	15.3	1.6	-1.6
1483	22294.9	51.5	68.8	55.7	59.8	75.6	15.4	1.6	-1.6
1487	21479.9	51.5	68.7	56.4	57.8	75.5	15.4	1.6	-1.6

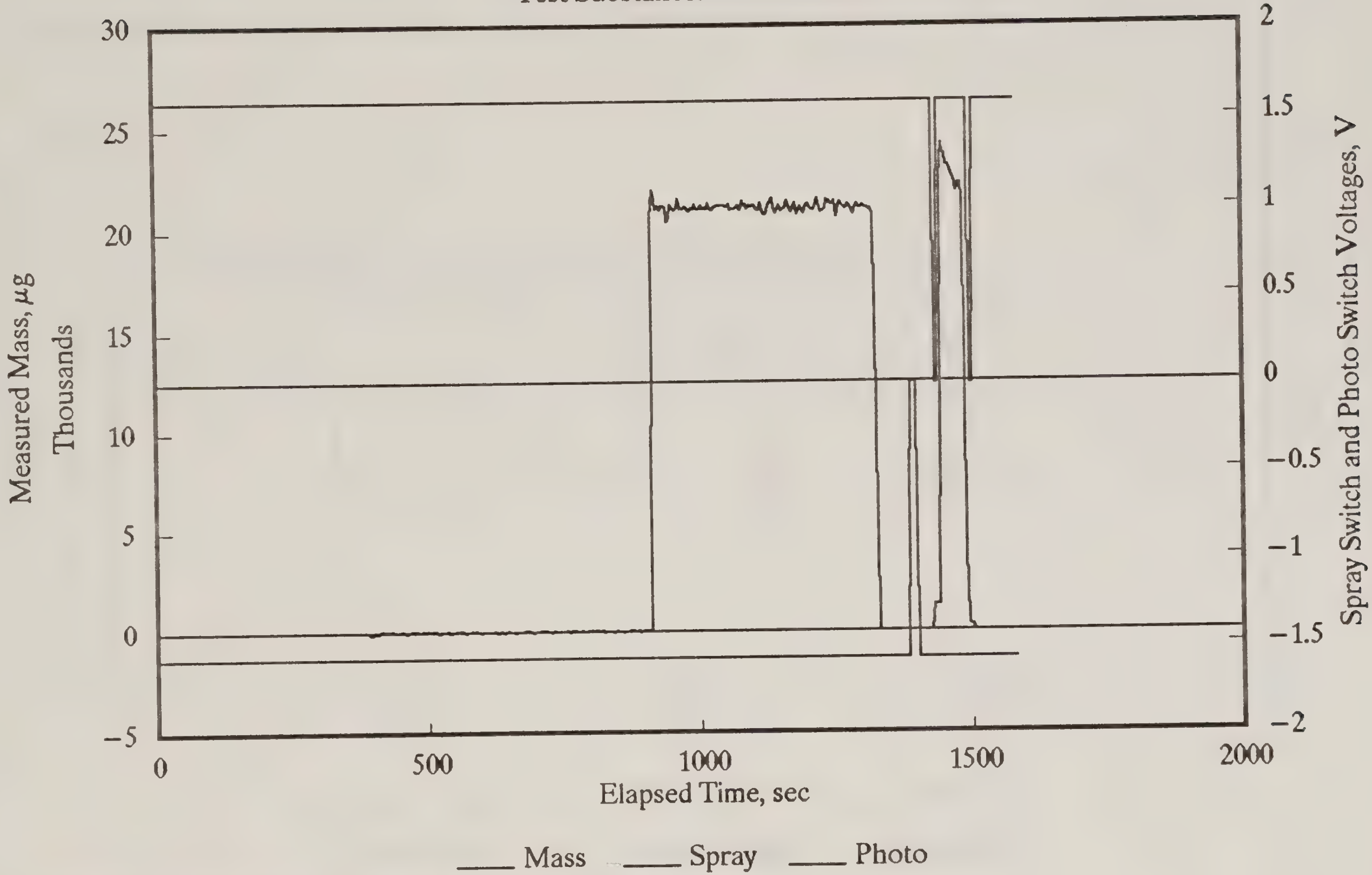
Project 6819.7 -- Droplet-Evaporation Test Results

Test Number:	110392F	Initial Drop Time, s:	1433
Substance:	WHO Water	Initial Total Mass, µg:	1273.5
Target Drop Size:	400 µm	Average Initial Drop Mass, µg:	12.01
Target Air Velocity:	300 ft/min	Average Initial Drop Size, µm:	301
Target Temperature:	59 °F	Ending Evaporation Time, s:	1497
Target RH:	60 %	Ending Total Mass, µg:	294.2
Initial # of Drops:	106	Overall Evaporation Period, s:	64
Average DSD Fiber Diameter in µm:	97.3	Total Mass Loss, µg:	979.4
Test-Substance Density in g/mL:	1.00	Overall Evap. Rate, ng/s:	144.4

Elapsed Time, sec	Microbalance Mass, µg	Meter Temperature, °F	Meter Relative Humidity, %	Drop Temperature, °F	Calculated Drop Relative Humidity, %	Microbalance Temperature, °F	Flow Rate, L/min	Photo Switch Voltage, V	Spray Switch Voltage, V
1490	4020.2	51.5	68.8	65.3	44.2	75.6	15.4	1.6	-1.6
1494	370.5	51.5	68.8	69.0	38.7	75.5	15.3	1.6	-1.6
1497	294.2	51.5	68.8	69.4	38.7	75.6	15.3	-0.0	-1.6
1501	292.5	51.5	67.8	70.3	37.0	75.7	15.2	-0.0	-1.6
1505	-5.8	51.5	67.8	70.0	37.0	75.7	15.2	1.6	-1.6
1508	-6.9	51.5	67.8	70.0	37.0	75.7	15.3	1.6	-1.6
1512	-7.3	51.5	67.8	70.5	37.0	75.7	15.2	1.6	-1.6
1515	-6.5	51.5	67.8	69.9	37.0	75.8	15.3	1.6	-1.6
1519	-6.2	51.5	67.7	69.7	36.9	75.8	15.4	1.6	-1.6
1522	-6.8	51.5	67.7	70.0	36.9	75.7	15.3	1.6	-1.6
1526	-6.9	51.5	67.8	69.9	37.0	75.7	15.3	1.6	-1.6
1530	-6.7	51.5	67.7	69.9	36.9	75.7	15.4	1.6	-1.6
1533	-6.6	51.5	67.8	70.1	37.0	75.8	15.3	1.6	-1.6
1537	-7.5	51.5	67.7	70.0	36.9	75.7	15.2	1.6	-1.6
1540	-6.5	51.5	67.8	70.0	37.0	75.8	15.3	1.6	-1.6
1544	-6.5	51.5	67.8	70.0	37.0	75.8	15.3	1.6	-1.6
1547	-7.3	51.5	67.7	70.2	36.9	75.7	15.2	1.6	-1.6
1551	-6.1	51.5	67.9	70.4	37.0	75.8	15.4	1.6	-1.6
1554	-6.3	51.5	67.7	70.6	35.8	75.8	15.3	1.6	-1.6
1558	-6.6	51.5	68.0	70.6	35.9	75.8	15.4	1.6	-1.6
1562	-6.8	51.5	67.8	70.7	35.8	75.8	15.3	1.6	-1.6
1565	-7.5	51.5	67.8	70.9	35.8	75.8	15.4	1.6	-1.6
1569	-7.1	51.5	67.7	71.3	35.8	75.7	15.3	1.6	-1.6
1572	-6.5	51.5	67.8	71.2	35.8	75.8	15.4	1.6	-1.6
1576	-7.9	51.5	67.7	70.9	35.8	75.8	15.3	1.6	-1.6
1579	-7.0	51.5	67.7	71.5	35.8	75.8	15.3	1.6	-1.6
	Averages:	51.5	70.4	64.4	47.8	75.6	15.4		

Test Number: 110392F

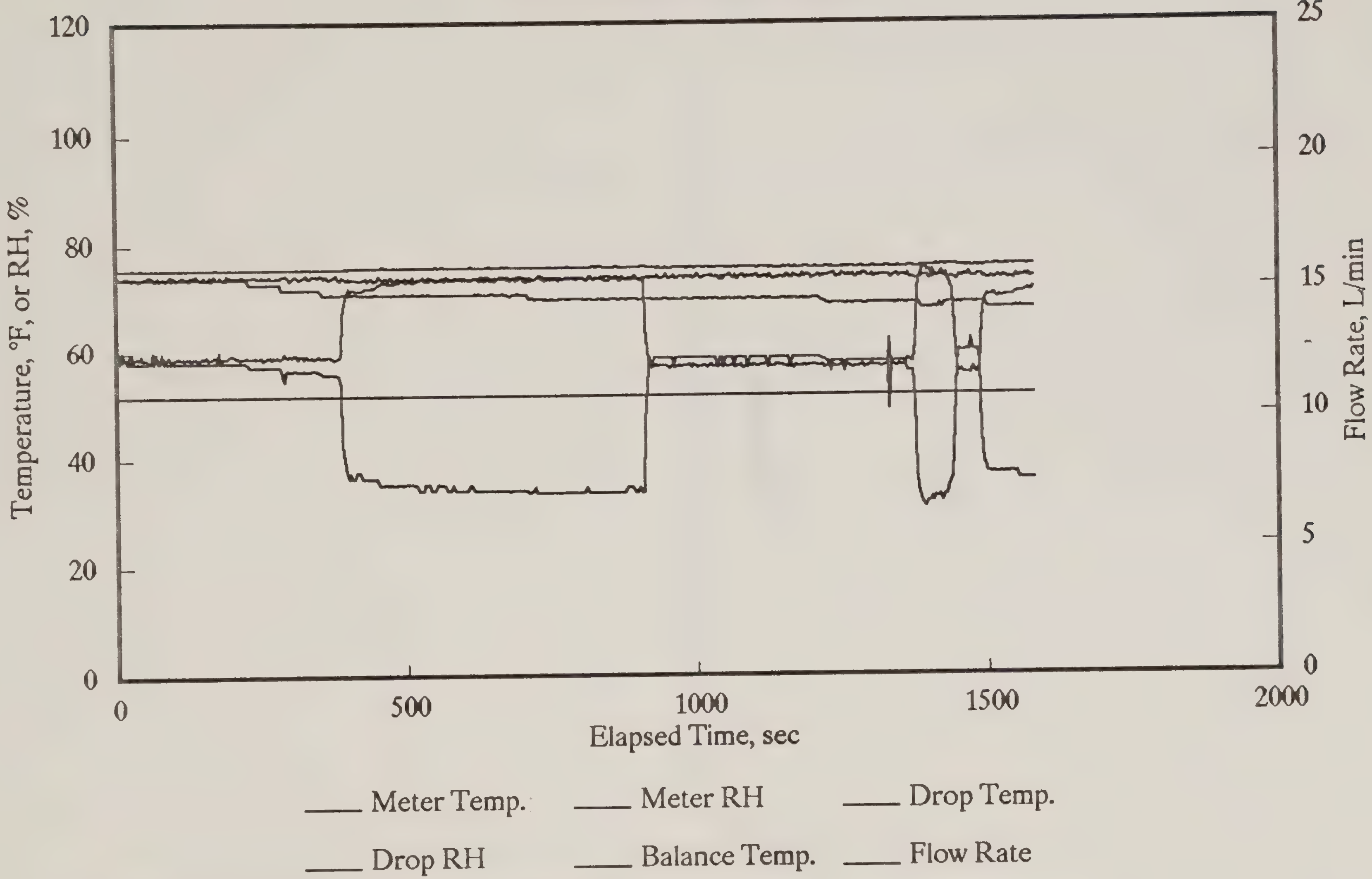
Test Substance: WHO Water



Target Drop Size: 400 μm; Target Air Velocity: 300 ft/min.
Target Drop Temperature: 59 °F; Target Drop RH: 60 %.

Test Number: 110392F

Test Substance: WHO Water



Target Drop Size: 400 μm; Target Air Velocity: 300 ft/min.
Target Drop Temperature: 59 °F; Target Drop RH: 60 %.

APPENDIX D

TABULATED RESULTS OF THE DROPLET-EVAPORATION TESTS

Table D-1. Results of Droplet-Evaporation Tests (Page 1 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	091092D	Ambient (80)	100	Ambient (71)	0		211	38.0
WHO water	091092E	Ambient (79)	100	Ambient (70)	0		215	24.4
WHO water	091192A	77	100	30	30		195	48.2
WHO water	091192B	77	100	30	30		200	60.8
WHO water	091192G	77	100	30	40		206	83.0
WHO water	091492A	77	100	30	40		202	82.0
WHO water	091592A	77	100	30	50		200	78.8
WHO water	091592B	77	100	30	50		192	77.8
WHO water	091192C	77	100	60	30		184	41.0
WHO water	091192D	77	100	60	30		194	55.2
WHO water	091492B	77	100	60	40		213	91.1
WHO water	091492C	77	100	60	40		198	74.1
WHO water	091592C	77	100	60	50		202	77.9
WHO water	091592D	77	100	60	50		191	72.4
WHO water	091192E	77	100	90	30		206	38.7
WHO water	091192F	77	100	90	30		208	52.8
WHO water	091492D	77	100	90	40		191	33.2
WHO water	091492E	77	100	90	40		182	16.4
WHO water	091592F	77	100	90	50		175	35.3
WHO water	091592G	77	100	90	50		185	25.6
WHO water	073092A	Ambient (78)	250	Ambient (78)	0		238	15.3
WHO water	073092B	Ambient (78)	250	Ambient (77)	0		269	28.8
WHO water	073092C	77	250	30	125		243	188.3
WHO water	073092D	77	250	30	125		236	149.8
WHO water	073192A	77	250	30	125		234	116.5
WHO water	090192A	77	250	30	150		274	196.5
WHO water	090192B	77	250	30	150		278	220.8
WHO water	090192C	77	250	30	150		276	204.3
WHO water	090392A	77	250	30	175		266	180.6
WHO water	090392B	77	250	30	175		272	173.8
WHO water	090392C	77	250	30	175		279	213.0

Table D–1. Results of Droplet–Evaporation Tests (Page 2 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	073192B	77	250	60	125		237	133.5
WHO water	073192D	77	250	60	125		226	101.2
WHO water	082592A	77	250	60	125		267	147.4
WHO water	082592B	77	250	60	125		265	125.4
WHO water	082592C	77	250	60	125		254	132.4
WHO water	090192D	77	250	60	150		260	157.9
WHO water	090192E	77	250	60	150		281	173.1
WHO water	090192F	77	250	60	150		293	202.6
WHO water	090392D	77	250	60	175		260	149.6
WHO water	090392E	77	250	60	175		273	143.9
WHO water	090492A	77	250	60	175		266	165.9
WHO water	073192E	77	250	90	125		279	141.5
WHO water	082692B	77	250	90	125		276	76.9
WHO water	083192A	77	250	90	125		244	52.3
WHO water	083192B	77	250	90	125		245	60.7
WHO water	083192C	77	250	90	125		254	55.0
WHO water	090192G	77	250	90	150	Low initial mass	234	97.4
WHO water	090292A	77	250	90	150		270	53.0
WHO water	090292B	77	250	90	150		277	76.1
WHO water	090292C	77	250	90	150		283	71.3
WHO water	090292D	77	250	90	175		260	86.5
WHO water	090292F	77	250	90	175		263	68.7
WHO water	090292G	77	250	90	175		276	70.5
WHO water	091092F	Ambient (80)	400	Ambient (72)	0		292	17.6
WHO water	091092G	Ambient (80)	400	Ambient (72)	0		288	17.9
WHO water	090492B	77	400	30	200		323	294.3
WHO water	090492C	77	400	30	200		311	231.5
WHO water	090492F	77	400	30	250		304	253.5
WHO water	090492G	77	400	30	250		307	261.4
WHO water	090992C	77	400	30	300		294	245.1
WHO water	090992D	77	400	30	300		293	248.3

Table D–1. Results of Droplet–Evaporation Tests (Page 3 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	090492D	77	400	60	200		308	171.3
WHO water	090492E	77	400	60	200		315	202.7
WHO water	090992A	77	400	60	250		301	166.8
WHO water	090992B	77	400	60	250		301	158.3
WHO water	090992E	77	400	60	300		299	178.0
WHO water	090992F	77	400	60	300		289	170.7
WHO water	090892A	77	400	90	200		300	97.8
WHO water	090892B	77	400	90	200		309	92.4
WHO water	090892C	77	400	90	250		292	107.5
WHO water	090892D	77	400	90	250		297	91.0
WHO water	091092A	77	400	90	300	Questionable test	302	102.5
WHO water	091092B	77	400	90	300		306	113.4
WHO water	091092C	77	400	90	300		301	112.4
WHO water	092492A	Ambient (94)	250	Ambient (34)	0		247	47.6
WHO water	092492B	Ambient (94)	250	Ambient (32)	0		238	37.5
WHO water	092492C	104	250	30	125		276	229.1
WHO water	092492D	104	250	30	125		252	189.2
WHO water	092992D	104	250	30	150		234	184.4
WHO water	092992E	104	250	30	150		240	175.2
WHO water	093092D	104	250	30	175		247	215.0
WHO water	093092E	104	250	30	175		232	199.6
WHO water	092492E	104	250	60	125		243	179.9
WHO water	092492F	104	250	60	125	Questionable test	247	138.3
WHO water	092992A	104	250	60	125		258	170.7
WHO water	092992F	104	250	60	150		231	102.6
WHO water	092992G	104	250	60	150		233	144.7
WHO water	100292A	104	250	60	175		228	133.0
WHO water	100292B	104	250	60	175		242	156.8
WHO water	092992B	104	250	90	125		246	68.4
WHO water	092992C	104	250	90	125		231	77.2
WHO water	093092A	104	250	90	150		250	100.7
WHO water	093092B	104	250	90	150		238	111.3
WHO water	100792A	104	250	90	175		237	101.6
WHO water	100792B	104	250	90	175		237	134.4

Table D–1. Results of Droplet–Evaporation Tests (Page 4 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	100292C	Ambient (96)	400	Ambient (36)	0		255	41.7
WHO water	100292D	Ambient (95)	400	Ambient (37)	0		277	55.5
WHO water	100992A	104	400	30	200		250	229.2
WHO water	100992B	104	400	30	200		275	287.9
WHO water	101292A	104	400	30	250		267	282.2
WHO water	101292B	104	400	30	250		256	215.9
WHO water	101392A	104	400	30	300		261	221.5
WHO water	101392C	104	400	30	300		262	253.2
WHO water	100992C	104	400	60	200		264	207.3
WHO water	100992D	104	400	60	200		276	186.9
WHO water	101292C	104	400	60	250		244	188.9
WHO water	101292D	104	400	60	250		271	220.7
WHO water	101392D	104	400	60	300		276	227.2
WHO water	101392E	104	400	60	300		280	220.9
WHO water	100992E	104	400	90	200		264	107.7
WHO water	100992F	104	400	90	200		265	109.3
WHO water	101292E	104	400	90	250		277	120.5
WHO water	101292F	104	400	90	250		254	96.2
WHO water	101392F	104	400	90	300		268	122.6
WHO water	101392G	104	400	90	300		261	129.1
WHO water	110492B	Ambient (74)	100	Ambient (62)	0		192	13.0
WHO water	110492C	Ambient (74)	100	Ambient (58)	0		195	16.6
WHO water	110492D	59	100	30	40	Low initial mass	172	30.8
WHO water	110492E	59	100	30	40		190	64.1
WHO water	110492F	59	100	30	40	Low initial mass	173	37.2
WHO water	110592A	59	100	30	40		175	68.3
WHO water	110592E	59	100	30	50		189	88.1
WHO water	110592F	59	100	30	50		182	52.4
WHO water	110592B	59	100	60	40	Low initial mass	165	38.0
WHO water	110592C	59	100	60	40	Low initial mass	168	48.0
WHO water	110692A	59	100	60	50		200	54.1
WHO water	110692B	59	100	60	50		179	38.6

Table D-1. Results of Droplet-Evaporation Tests (Page 5 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	102692A	Ambient (80)	250	Ambient (36)	0		229	36.3
WHO water	102692B	Ambient (80)	250	Ambient (37)	0		252	38.8
WHO water	102792D	Ambient (78)	250	Ambient (44)	0		263	29.4
WHO water	102792E	Ambient (78)	250	Ambient (48)	0		262	30.2
WHO water	102792B	59	250	30	125		276	129.6
WHO water	102792C	59	250	30	125		257	135.4
WHO water	102892C	59	250	30	150	Questionable test	251	122.9
WHO water	102892D	59	250	30	150		262	123.7
WHO water	102892F	59	250	30	150		253	120.1
WHO water	102992D	59	250	30	175		251	116.5
WHO water	102992E	59	250	30	175		252	109.0
WHO water	102892A	59	250	60	125		243	60.4
WHO water	102892B	59	250	60	125		242	69.8
WHO water	102992A	59	250	60	150		260	89.8
WHO water	102992B	59	250	60	150		246	83.2
WHO water	102992F	59	250	60	175	Questionable test ?	261	97.1
WHO water	102992G	59	250	60	175	Questionable test	247	65.1
WHO water	103092A	59	250	60	175		272	92.6
WHO water	103092B	59	250	60	175		247	83.4
WHO water	110392G	Ambient (74)	400	Ambient (52)	0	Low initial mass	272	25.2
WHO water	110392H	Ambient (75)	400	Ambient (54)	0		293	23.2
WHO water	110492A	Ambient (73)	400	Ambient (62)	0		311	19.8
WHO water	103092C	59	400	30	200		313	177.6
WHO water	103092D	59	400	30	200		318	151.4
WHO water	110292A	59	400	30	250		289	169.9
WHO water	110292B	59	400	30	250		296	177.5
WHO water	110392A	59	400	30	300		323	234.9
WHO water	110392B	59	400	30	300	Low initial mass ?	282	135.0
WHO water	110392C	59	400	30	300	Questionable test	315	185.5
WHO water	110392D	59	400	30	300		318	186.2

Table D-1. Results of Droplet-Evaporation Tests (Page 6 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
WHO water	103092E	59	400	60	200		318	127.6
WHO water	103092F	59	400	60	200	Low initial mass ?	278	103.0
WHO water	110292C	59	400	60	250		311	142.6
WHO water	110292D	59	400	60	250		305	165.0
WHO water	110392E	59	400	60	300		308	113.1
WHO water	110392F	59	400	60	300		301	144.4
Sulfur 6L/WHO water[c]	120292A	Ambient (74)	100	Ambient (23)	0		246	32.1
Sulfur 6L/WHO water	120292B	Ambient (75)	100	Ambient (21)	0		212	22.3
Sulfur 6L/WHO water	120192E	77	100	30	40		248	90.7
Sulfur 6L/WHO water	120192F	77	100	30	40		220	71.0
Sulfur 6L/WHO water	120292C	77	100	60	40		209	51.9
Sulfur 6L/WHO water	120292D	77	100	60	40		235	83.7
Sulfur 6L/WHO water	120292E	77	100	90	40		232	34.4
Sulfur 6L/WHO water	120292F	77	100	90	40		252	46.2
Sulfur 6L/WHO water	112492B	Ambient (78)	250	Ambient (41)	0	Questionable test	317	42.5
Sulfur 6L/WHO water	112492C	Ambient (80)	250	Ambient (42)	0		292	44.7
Sulfur 6L/WHO water	112492D	Ambient (80)	250	Ambient (42)	0		303	40.7
Sulfur 6L/WHO water	112492E	77	250	30	150		314	227.9
Sulfur 6L/WHO water	112492F	77	250	30	150		306	251.8
Sulfur 6L/WHO water	112492G	77	250	60	150		282	145.5
Sulfur 6L/WHO water	112592A	77	250	60	150		325	229.6
Sulfur 6L/WHO water	112592B	77	250	90	150		302	101.7
Sulfur 6L/WHO water	112592C	77	250	90	150		315	101.6
Sulfur 6L/WHO water	112592D	Ambient (80)	400	Ambient (36)	0		350	50.2
Sulfur 6L/WHO water	112592E	Ambient (80)	400	Ambient (36)	0		358	51.6
Sulfur 6L/WHO water	113092A	77	400	30	250	Low initial mass	327	289.7
Sulfur 6L/WHO water	113092B	77	400	30	250	Low initial mass	326	277.7
Sulfur 6L/WHO water	113092C	77	400	30	250	High initial mass	395	389.0
Sulfur 6L/WHO water	113092D	77	400	30	250		359	395.0
Sulfur 6L/WHO water	113092E	77	400	30	250		347	337.4
Sulfur 6L/WHO water	120192A	77	400	60	250		347	277.1
Sulfur 6L/WHO water	120192B	77	400	60	250		364	350.4
Sulfur 6L/WHO water	120192C	77	400	90	250		356	150.7
Sulfur 6L/WHO water	120192D	77	400	90	250		342	145.2

Table D–1. Results of Droplet–Evaporation Tests (Page 7 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
Sulfur 6L/WHO water	121792A	Ambient (95)	250	Ambient (15)	0		317	86.1
Sulfur 6L/WHO water	121792B	Ambient (96)	250	Ambient (13)	0		290	65.2
Sulfur 6L/WHO water	121792D	104	250	30	150		314	402.8
Sulfur 6L/WHO water	121792E	104	250	30	150		307	267.6
Sulfur 6L/WHO water	121892A	104	250	60	150		317	275.0
Sulfur 6L/WHO water	121892B	104	250	60	150		280	125.6
Sulfur 6L/WHO water	122392D	104	250	90	150		309	113.8
Sulfur 6L/WHO water	122392E	104	250	90	150		334	141.1
Sulfur 6L/WHO water	122192A	Ambient (93)	400	Ambient (22)	0	Questionable test	389	79.8
Sulfur 6L/WHO water	122192B	Ambient (93)	400	Ambient (22)	0		356	71.4
Sulfur 6L/WHO water	122192C	Ambient (93)	400	Ambient (23)	0		370	76.9
Sulfur 6L/WHO water	122292A	104	400	30	250		335	406.5
Sulfur 6L/WHO water	122292B	104	400	30	250		381	495.1
Sulfur 6L/WHO water	122292C	104	400	60	250	Low initial mass	346	420.1
Sulfur 6L/WHO water	122292E	104	400	60	250		359	428.6
Sulfur 6L/WHO water	122292F	104	400	60	250		356	348.9
Sulfur 6L/WHO water	122392B	104	400	90	250		350	235.7
Sulfur 6L/WHO water	122392C	104	400	90	250		357	191.2
Sulfur 6L/WHO water	120392A	Ambient (71)	100	Ambient (19)	0	High initial mass	266	45.6
Sulfur 6L/WHO water	120392B	Ambient (72)	100	Ambient (19)	0		235	32.6
Sulfur 6L/WHO water	120392C	Ambient (70)	100	Ambient (15)	0		227	29.2
Sulfur 6L/WHO water	120392D	59	100	30	40		219	48.8
Sulfur 6L/WHO water	120392F	59	100	30	40		222	57.4
Sulfur 6L/WHO water	120392G	59	100	60	40		229	37.5
Sulfur 6L/WHO water	120492A	59	100	60	40	High initial mass	259	49.2
Sulfur 6L/WHO water	121092C	59	100	60	40		223	37.5
Sulfur 6L/WHO water	120492B	Ambient (71)	250	Ambient (41)	0	Low initial mass	284	37.1
Sulfur 6L/WHO water	120492C	Ambient (71)	250	Ambient (45)	0	High initial mass	339	46.0
Sulfur 6L/WHO water	120492D	Ambient (72)	250	Ambient (44)	0		316	45.6
Sulfur 6L/WHO water	120792A	Ambient (66)	250	Ambient (38)	0	High initial mass ?	319	50.5
Sulfur 6L/WHO water	120892B	Ambient (69)	250	Ambient (27)	0		306	61.2

Table D–1. Results of Droplet–Evaporation Tests (Page 8 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, µm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, µm	Overall Evaporation Rate, ng/s
Sulfur 6L/WHO water	120892C	59	250	30	150		319	207.9
Sulfur 6L/WHO water	120892D	59	250	30	150		319	171.1
Sulfur 6L/WHO water	120892E	59	250	60	150		303	132.2
Sulfur 6L/WHO water	120892F	59	250	60	150		303	142.4
Sulfur 6L/WHO water	120792B	Ambient (67)	400	Ambient (38)	0	Low initial mass	328	47.6
Sulfur 6L/WHO water	120792C	Ambient (67)	400	Ambient (37)	0		348	47.9
Sulfur 6L/WHO water	120892A	Ambient (68)	400	Ambient (28)	0		354	54.3
Sulfur 6L/WHO water	120992A	59	400	30	250		358	347.0
Sulfur 6L/WHO water	120992B	59	400	30	250		363	340.5
Sulfur 6L/WHO water	120992C	59	400	60	250		348	178.7
Sulfur 6L/WHO water	121092B	59	400	60	250		344	209.9
Thuricide/water[d]	011593E	Ambient (73)	100	Ambient (28)	0		210	19.5
Thuricide/water	011593F	Ambient (74)	100	Ambient (27)	0		210	21.2
Thuricide/water	011893A	77	100	30	40	Questionable test ?	201	58.0
Thuricide/water	011893B	77	100	30	40		229	81.2
Thuricide/water	011893C	77	100	30	40		213	55.8
Thuricide/water	011893D	77	100	60	40		210	36.2
Thuricide/water	011893E	77	100	60	40		204	32.0
Thuricide/water	011593G	77	100	90	40		194	2.6
Thuricide/water	011593H	77	100	90	40		217	8.9
Thuricide/water	011293A	Ambient (76)	250	Ambient (34)	0		307	34.4
Thuricide/water	011293C	Ambient (77)	250	Ambient (43)	0		301	35.8
Thuricide/water	011293D	77	250	30	150		296	208.4
Thuricide/water	011293E	77	250	30	150		283	172.4
Thuricide/water	011293F	77	250	60	150		282	117.7
Thuricide/water	011293G	77	250	60	150		297	126.9
Thuricide/water	011393A	77	250	90	150		294	79.3
Thuricide/water	011393C	77	250	90	150	Questionable test	281	54.4
Thuricide/water	011393D	77	250	90	150		298	62.1
Thuricide/water	011393E	Ambient (79)	400	Ambient (28)	0		353	54.7
Thuricide/water	011393F	Ambient (79)	400	Ambient (24)	0		343	50.7
Thuricide/water	011393G	77	400	30	250		358	287.1
Thuricide/water	011393H	77	400	30	250		342	241.8

Table D–1. Results of Droplet–Evaporation Tests (Page 9 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
Thuricide/water	011493B	77	400	60	250		348	223.9
Thuricide/water	011493E	77	400	60	250		355	205.0
Thuricide/water	011593B	77	400	90	250		333	94.1
Thuricide/water	011593D	77	400	90	250		343	91.5
Thuricide/water	010693A	Ambient (94)	250	Ambient (14)	0		279	45.4
Thuricide/water	010693D	Ambient (94)	250	Ambient (12)	0		302	55.2
Thuricide/water	010793A	Ambient (92)	250	Ambient (16)	0		296	41.4
Thuricide/water	010793B	104	250	30	150		290	182.9
Thuricide/water	010793C	104	250	30	150		304	187.3
Thuricide/water	010793F	104	250	60	150		278	138.0
Thuricide/water	010793G	104	250	60	150		303	185.0
Thuricide/water	011193B	104	250	90	150		289	117.2
Thuricide/water	011193C	104	250	90	150		309	97.4
Thuricide/water	010693C	Ambient (94)	400	Ambient (12)	0		334	74.1
Thuricide/water	010793H	Ambient (94)	400	Ambient (17)	0		341	69.4
Thuricide/water	010893A	104	400	30	250	High initial mass	362	347.7
Thuricide/water	010893B	104	400	30	250		327	286.6
Thuricide/water	010893C	104	400	30	250		364	364.4
Thuricide/water	010893E	104	400	60	250		353	269.4
Thuricide/water	010893F	104	400	60	250		340	224.5
Thuricide/water	010893H	104	400	90	250		338	128.2
Thuricide/water	010893I	104	400	90	250		356	122.8
Thuricide/water	011993A	Ambient (73)	100	Ambient (40)	0		201	15.5
Thuricide/water	011993B	Ambient (74)	100	Ambient (39)	0		204	16.8
Thuricide/water	011993C	59	100	30	40		225	49.4
Thuricide/water	011993D	59	100	30	40	Low initial mass ?	185	21.8
Thuricide/water	011993E	59	100	30	40		191	21.5
Thuricide/water	011993F	59	100	60	40		214	28.5
Thuricide/water	011993G	59	100	60	40	High initial mass	234	37.1
Thuricide/water	012293A	59	100	60	40	Questionable test	203	38.8
Thuricide/water	012293B	59	100	60	40		204	29.4
Thuricide/water	012293C	Ambient (74)	250	Ambient (37)	0		294	39.0
Thuricide/water	012293D	Ambient (74)	250	Ambient (35)	0		302	46.0

Table D–1. Results of Droplet–Evaporation Tests (Page 10 of 10)

Test Substance	Test Number	Target Temperature,[a] °F	Target Drop Size, μm	Target Relative Humidity,[b] %	Air Velocity, ft/min	Comments	Average Drop Size, μm	Overall Evaporation Rate, ng/s
Thuricide/water	012593A	59	250	30	150		283	159.7
Thuricide/water	012593B	59	250	30	150		291	143.7
Thuricide/water	012593G	59	250	60	150		297	75.9
Thuricide/water	012593H	59	250	60	150		296	105.3
Thuricide/water	012593F	Ambient (72)	400	Ambient (18)	0		349	70.6
Thuricide/water	012593I	Ambient (74)	400	Ambient (17)	0		352	73.3
Thuricide/water	012693C	Ambient (72)	400	Ambient (16)	0		334	50.3
Thuricide/water	012693A	59	400	30	250		352	215.9
Thuricide/water	012693B	59	400	30	250		347	212.7
Thuricide/water	012693D	59	400	60	250		348	135.9
Thuricide/water	012693E	59	400	60	250	High initial mass	362	169.9
Thuricide/water	012693F	59	400	60	250		354	158.4

[a]The number in parentheses for each test conducted at ambient temperature is the average measured temperature during the test.

[b]The number in parentheses for each test conducted at ambient relative humidity is the average measured relative humidity during the test.

[c]This mixture was a 25% mixture by volume of Sulfur 6L with WHO water.

[d]This mixture was a 50% mixture by volume of Thuricide 48LV with Milli–Q water.

APPENDIX E

PLOTTED RESULTS OF THE DROPLET-EVAPORATION TESTS -- OVERALL EVAPORATION RATE VERSUS AIR VELOCITY

Droplet-Evaporation Test Results

WHO Water; Target Drop Size = 100 μm; Target Temperature = 77 °F

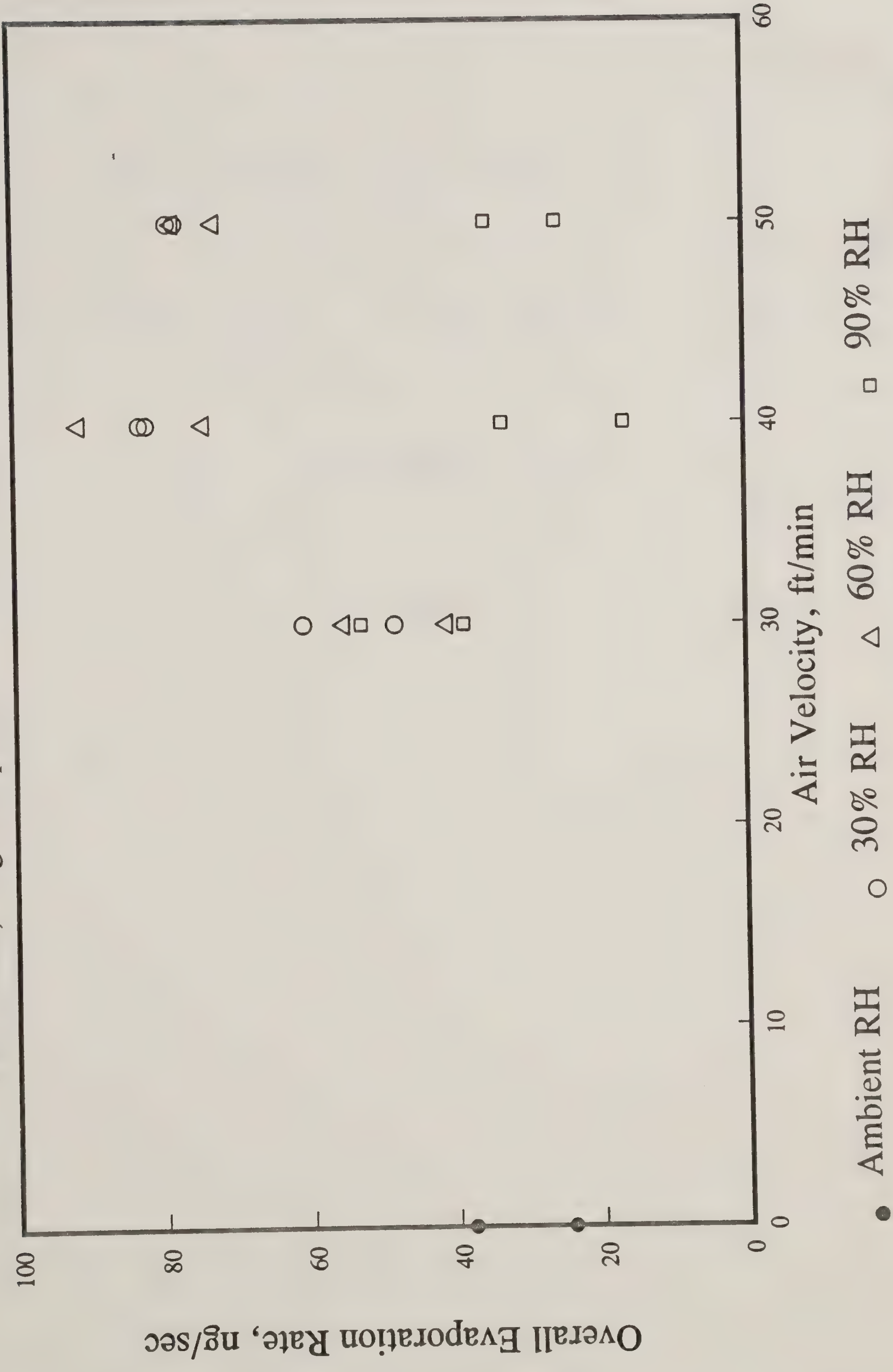


Figure E-1

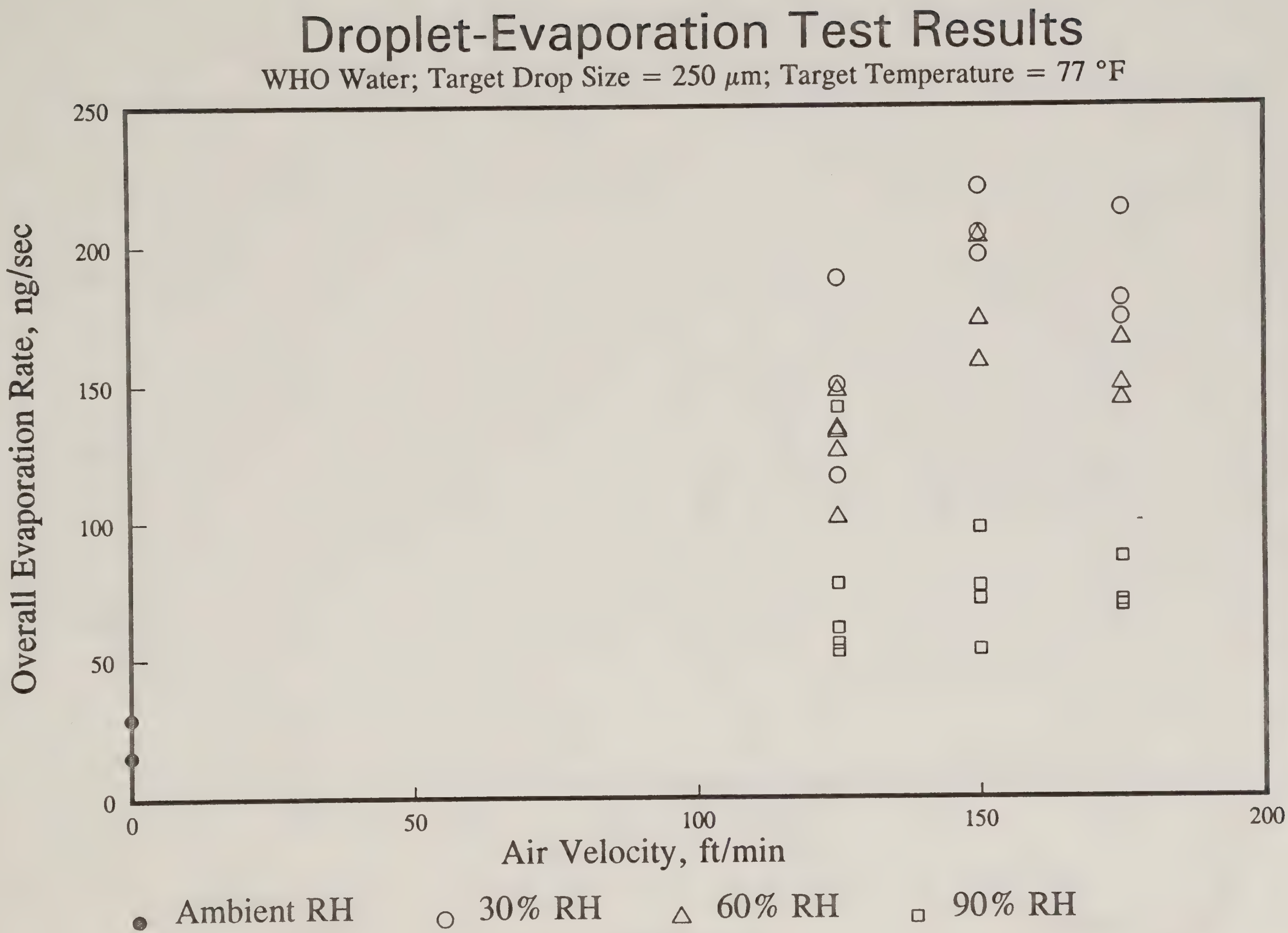

Droplet-Evaporation Test Results
WHO Water; Target Drop Size = 250 μm; Target Temperature = 77 °F
Overall Evaporation Rate, ng/sec
0
50
100
150
200
250
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-2

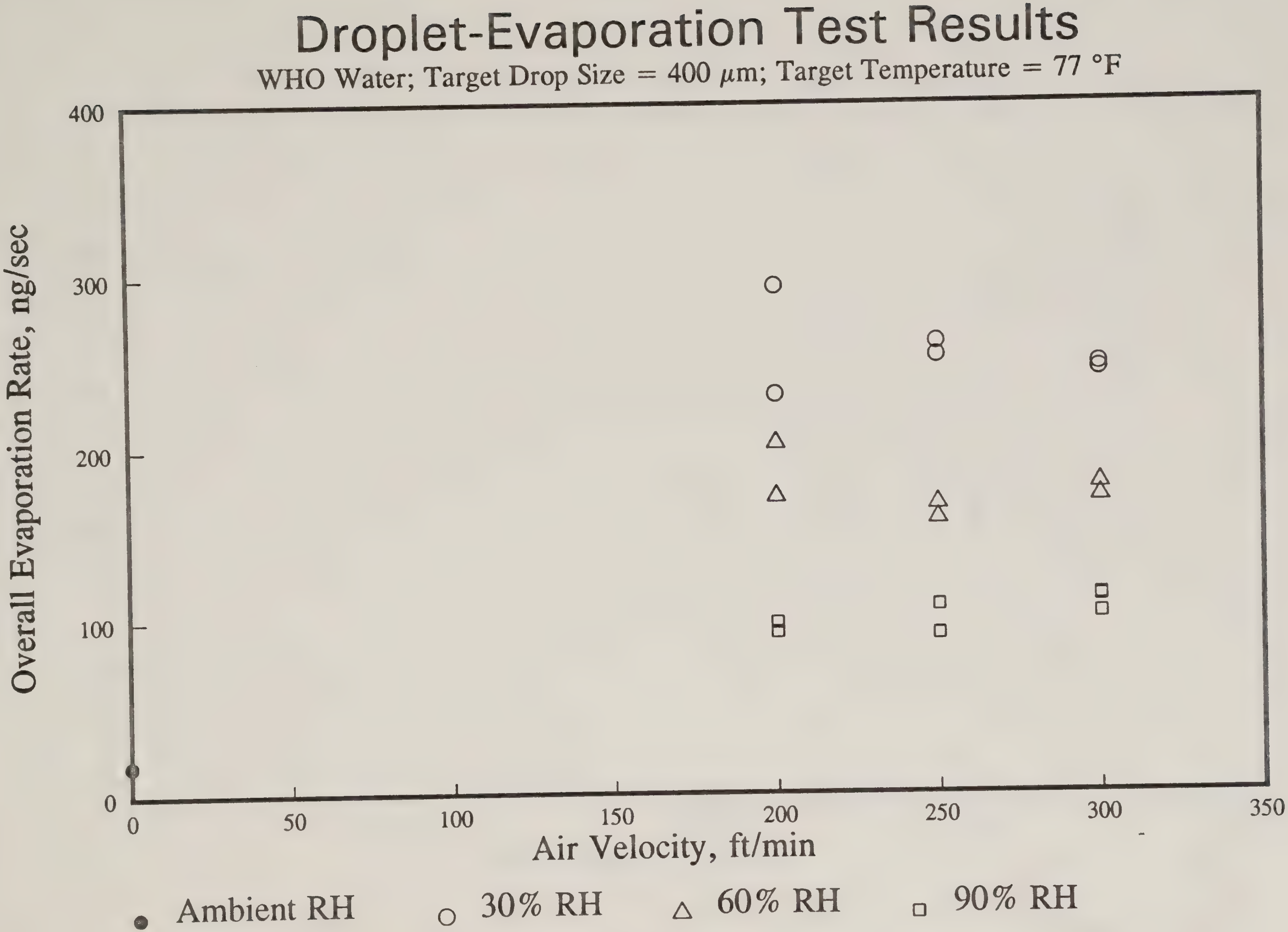

Droplet-Evaporation Test Results
WHO Water; Target Drop Size = 400 μm; Target Temperature = 77 °F
Overall Evaporation Rate, ng/sec
400
300
200
100
0
0
50
100
150
200
250
300
350
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-3

Droplet-Evaporation Test Results

WHO Water; Target Drop Size = 250 μm; Target Temperature = 104 °F

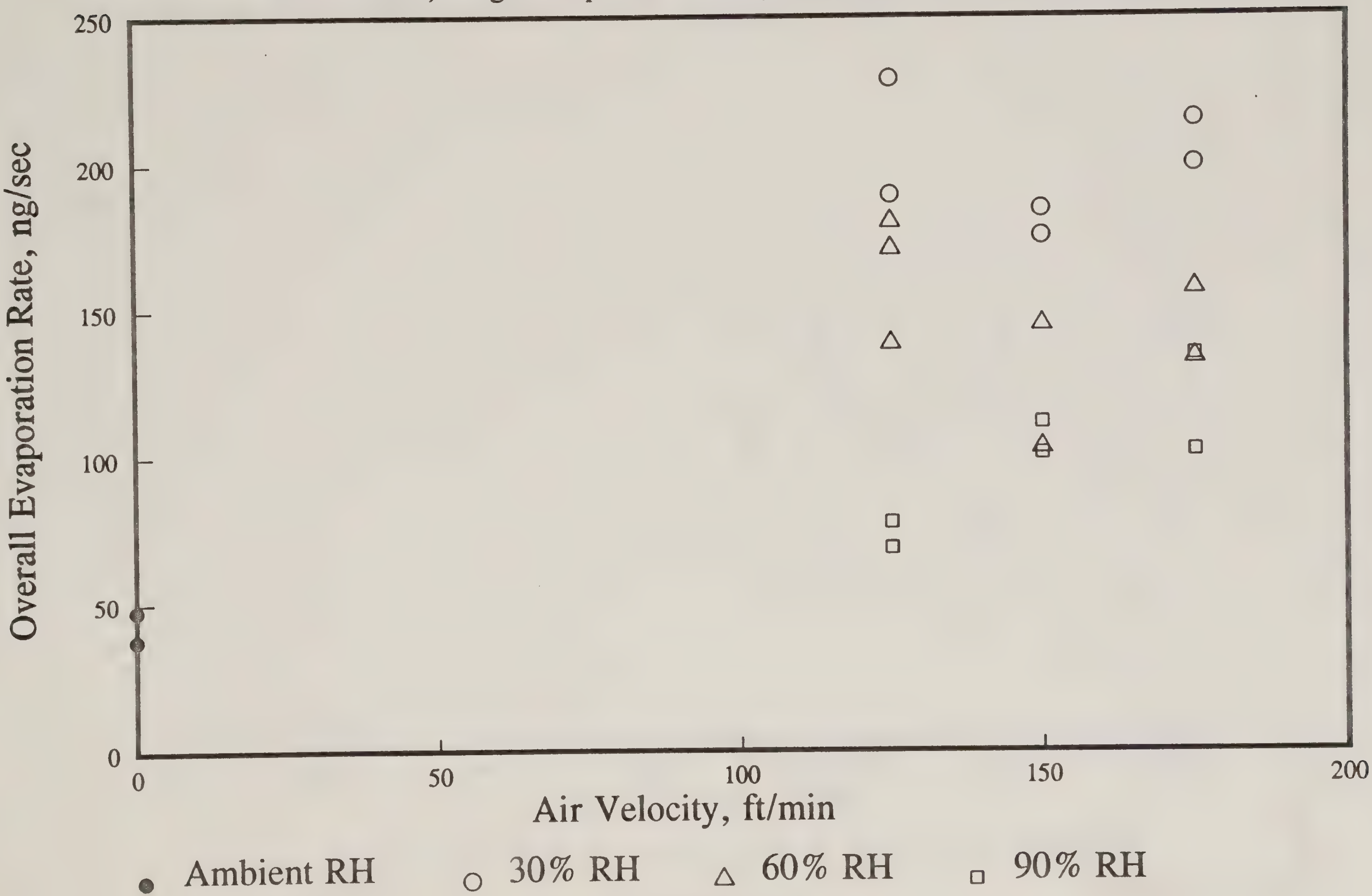


Figure E-4

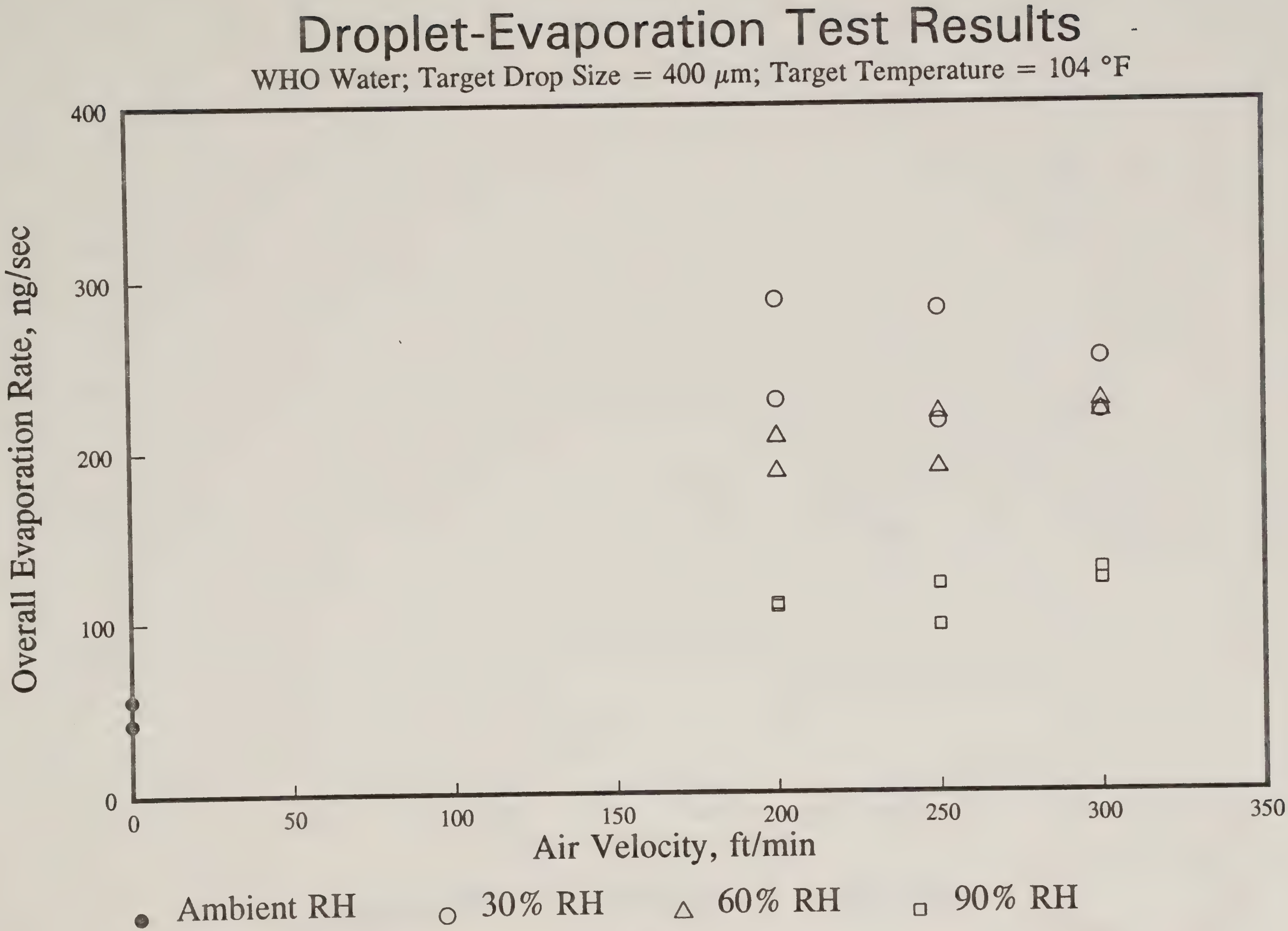

Droplet-Evaporation Test Results
WHO Water; Target Drop Size = 400 μm; Target Temperature = 104 °F
Overall Evaporation Rate, ng/sec
400
300
200
100
0
0
50
100
150
200
250
300
350
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-5

Droplet-Evaporation Test Results

WHO Water; Target Drop Size = 100 μm; Target Temperature = 59 °F

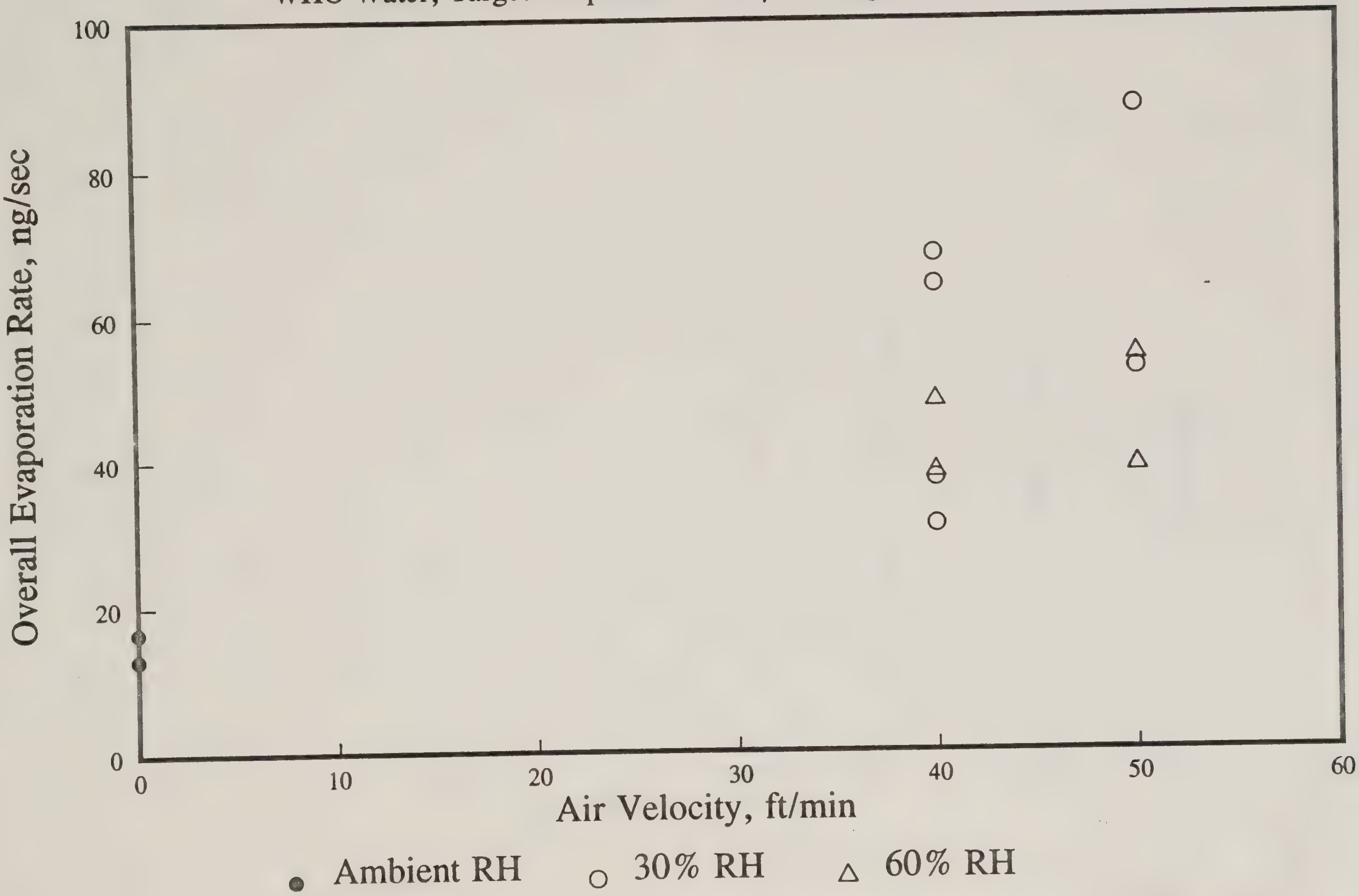


Figure E-6

Droplet-Evaporation Test Results

WHO Water; Target Drop Size = 250 μm; Target Temperature = 59 °F

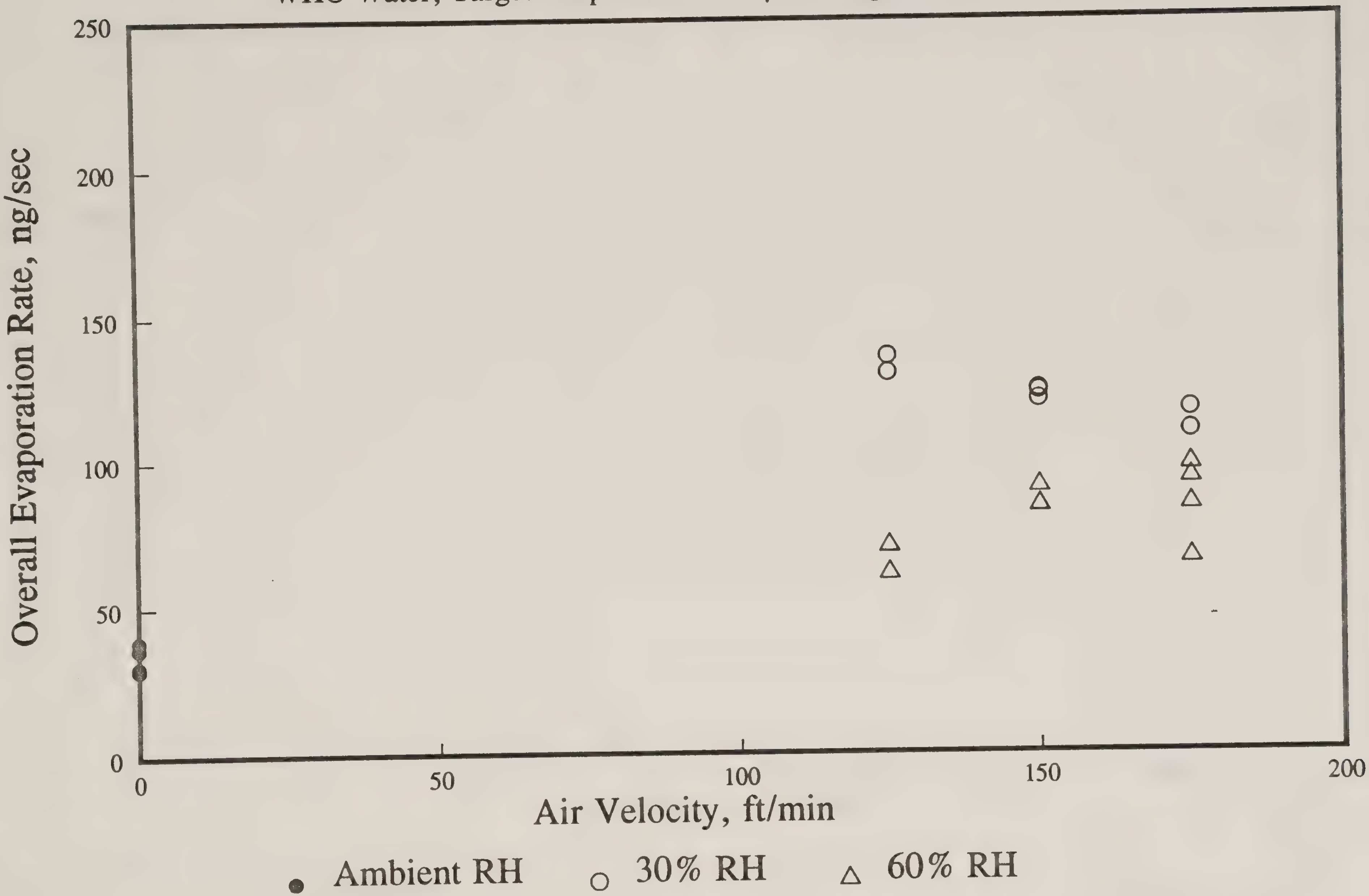


Figure E-7

Droplet-Evaporation Test Results

WHO Water; Target Drop Size = 400 μm; Target Temperature = 59 °F

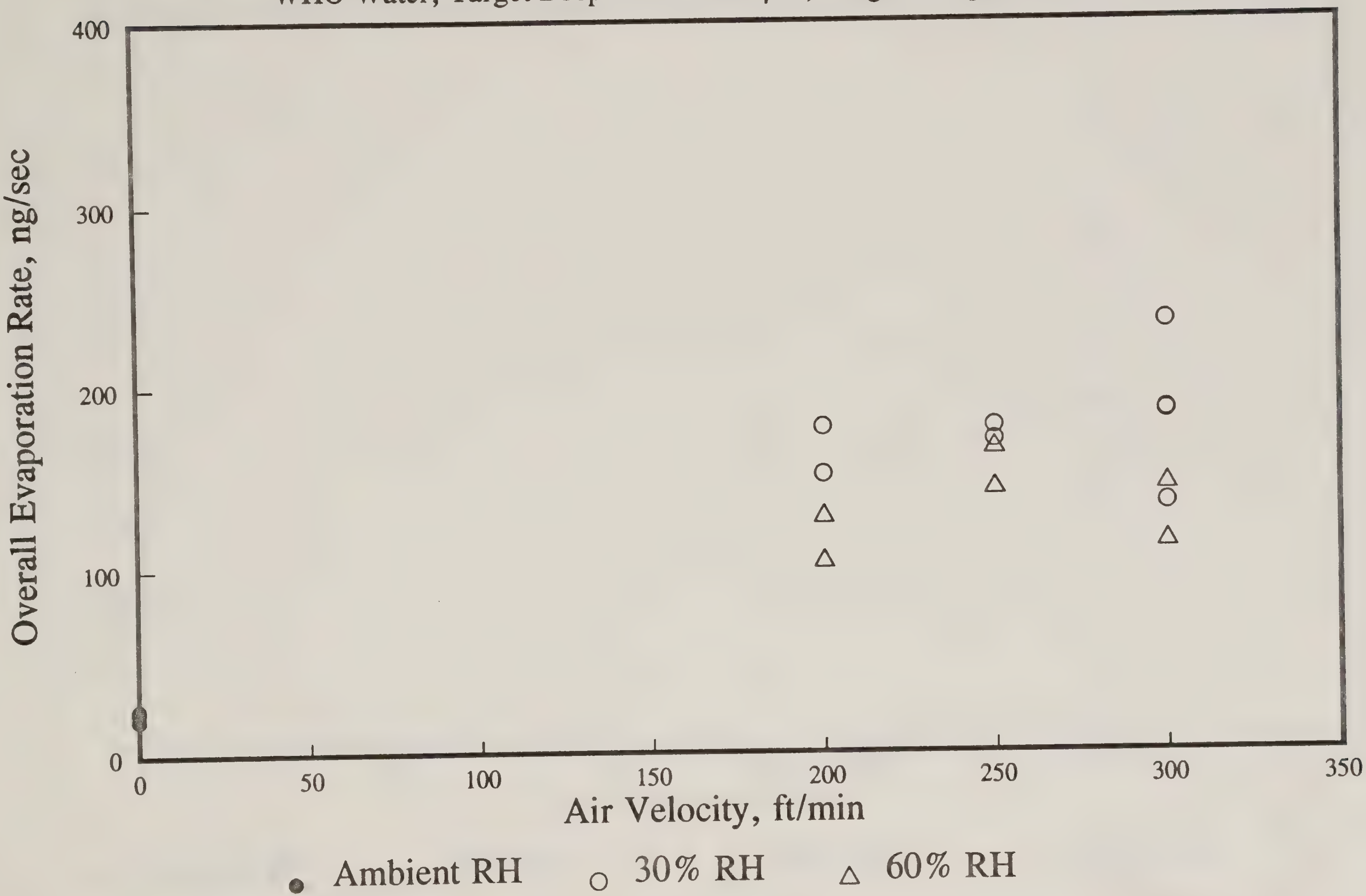


Figure E-8

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 100 μm; Target Temp. = 77 °F

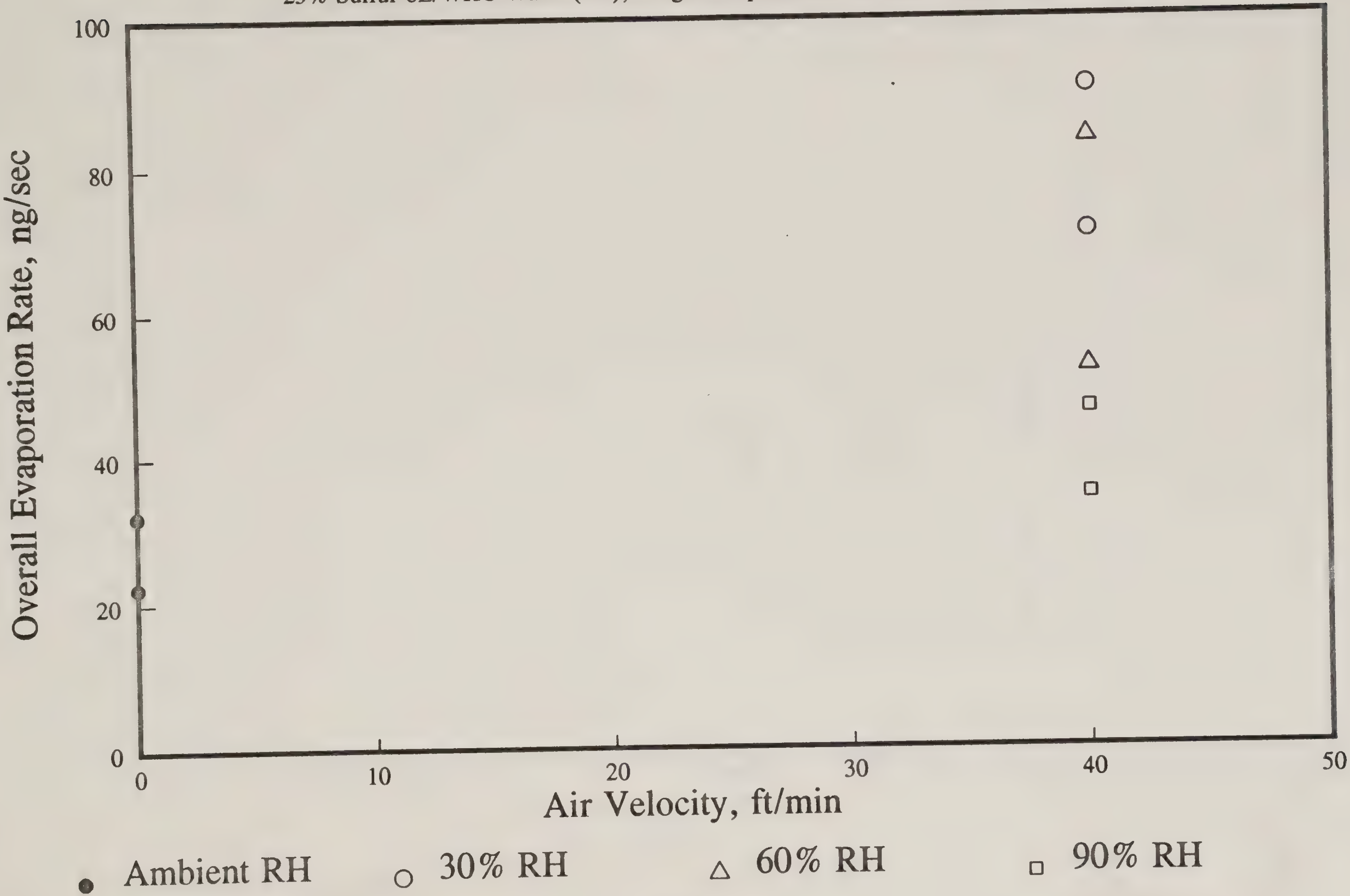


Figure E-9

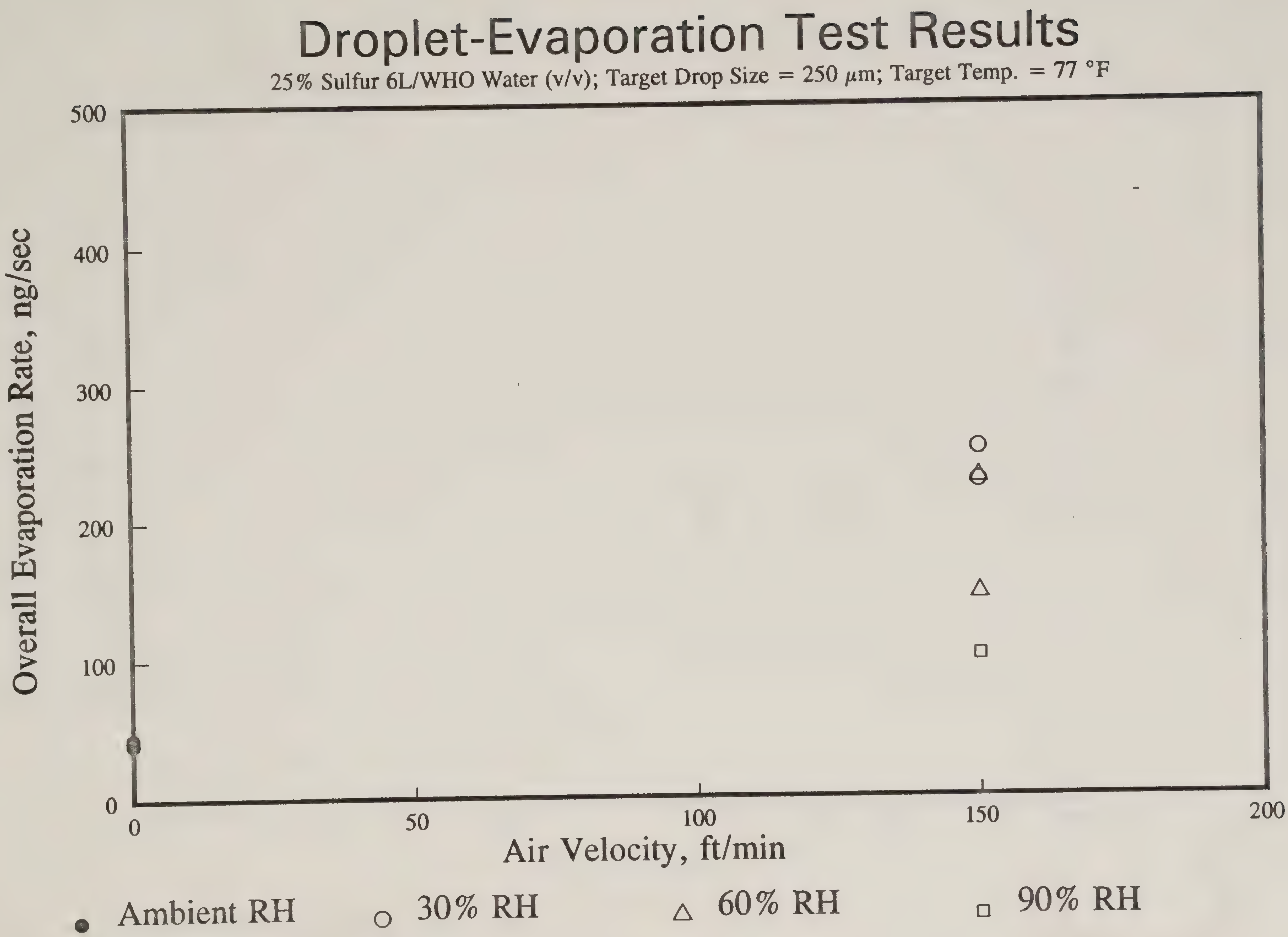
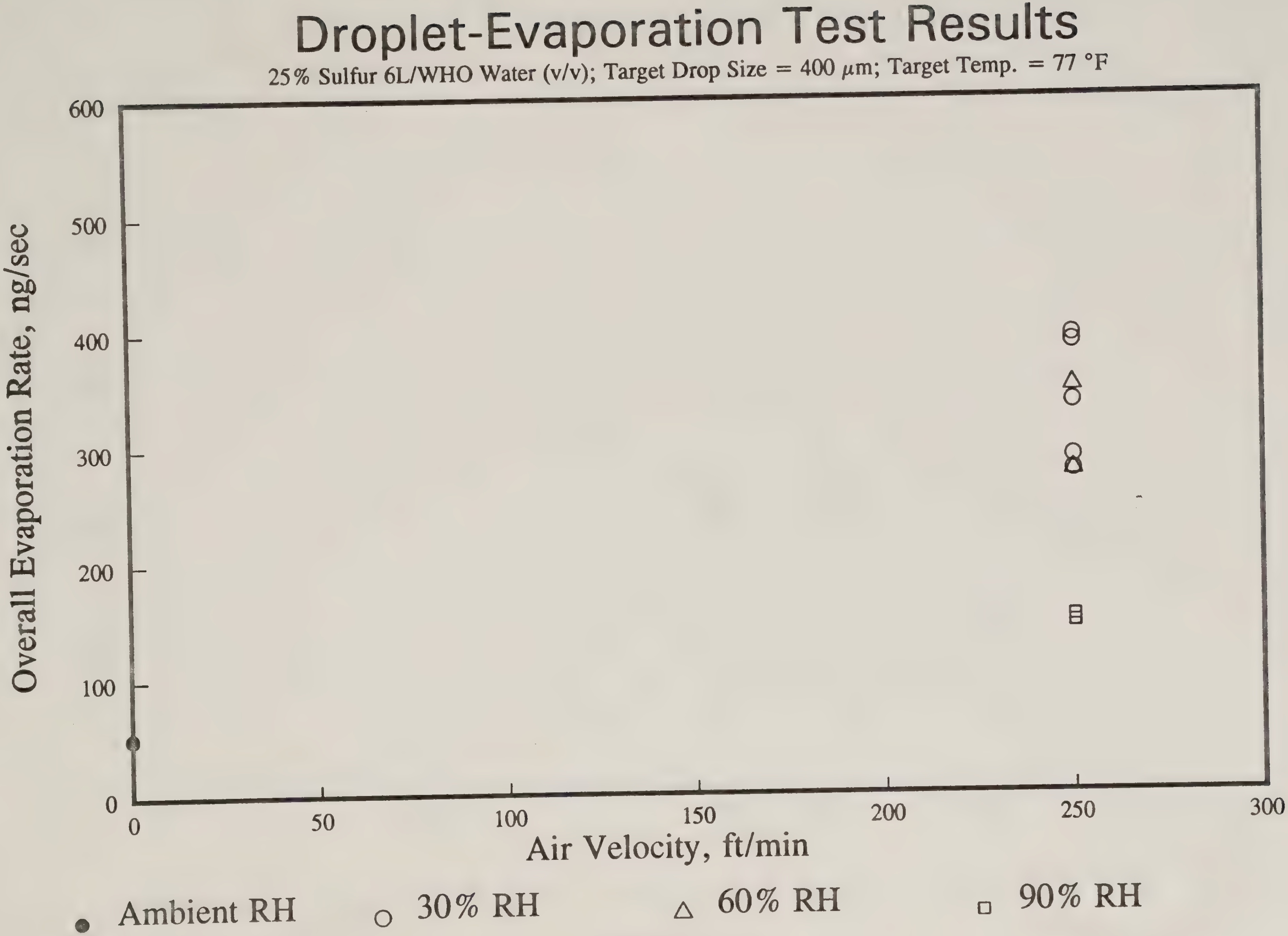

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 250 µm; Target Temp. = 77 °F
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-10



Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 400 μm; Target Temp. = 77 °F
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
600
0
50
100
150
200
250
300
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-11

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 250 μm; Target Temp. = 104 °F

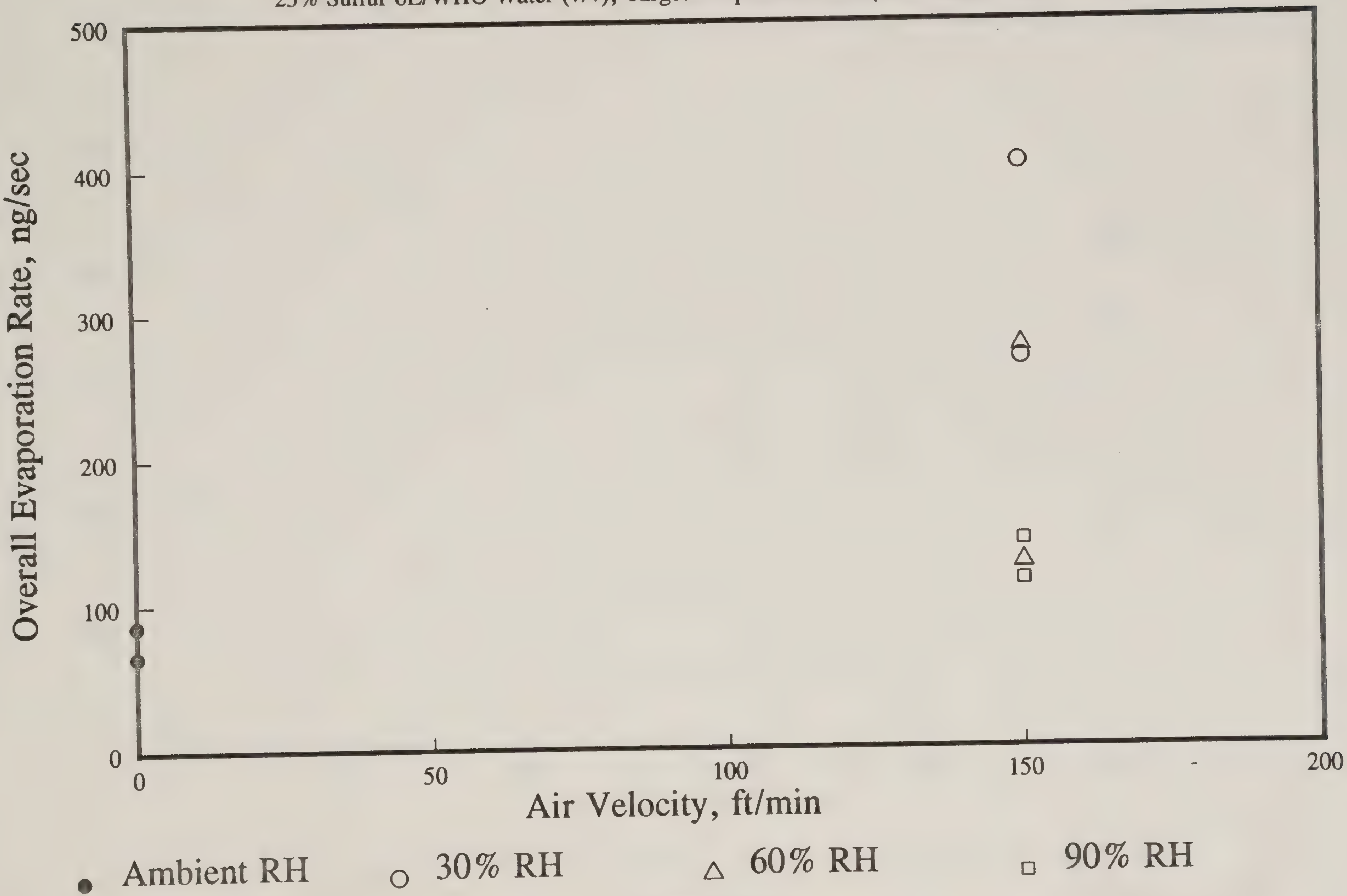


Figure E-12

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 400 μm; Target Temp. = 104 °F

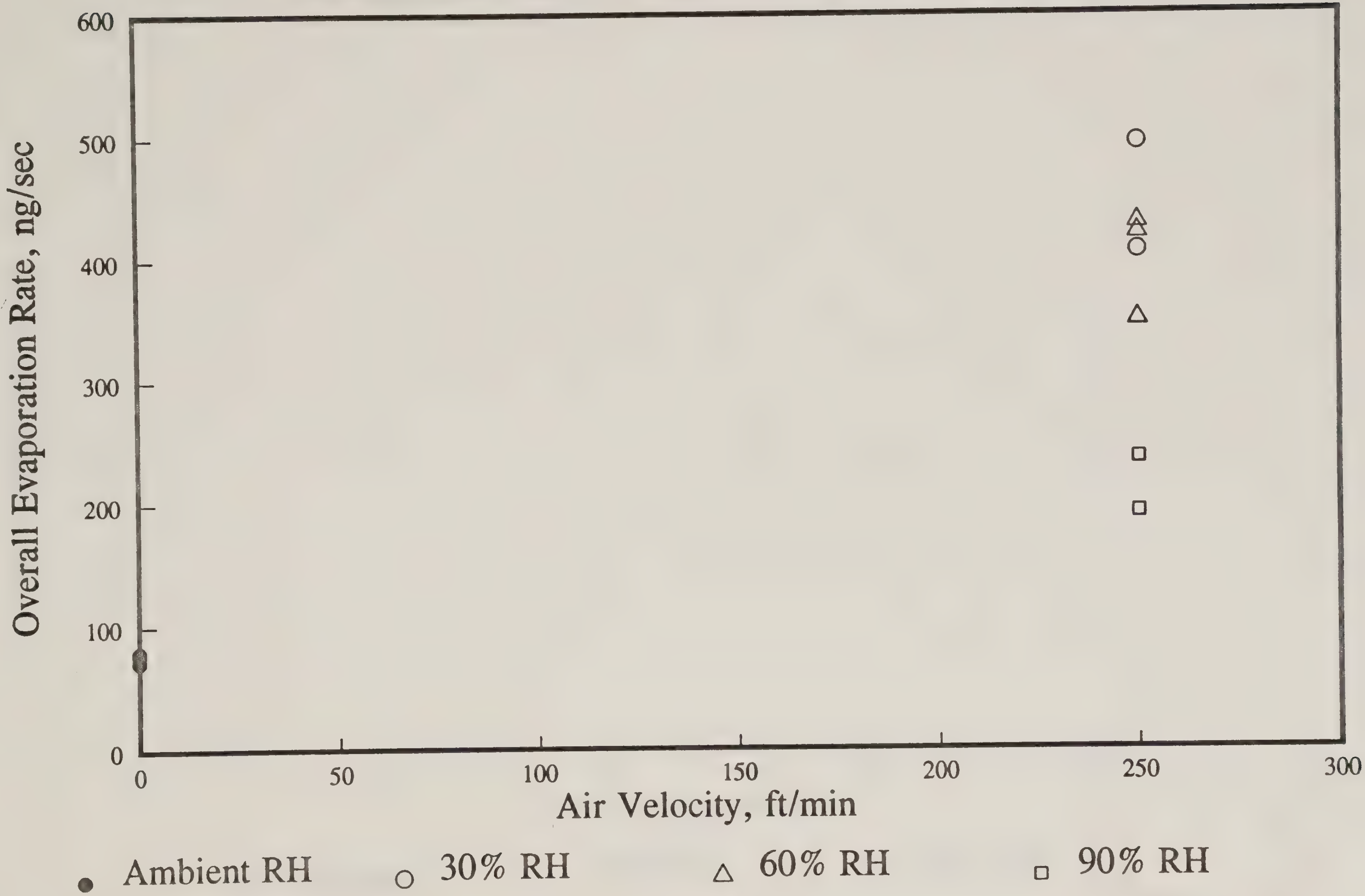


Figure E-13

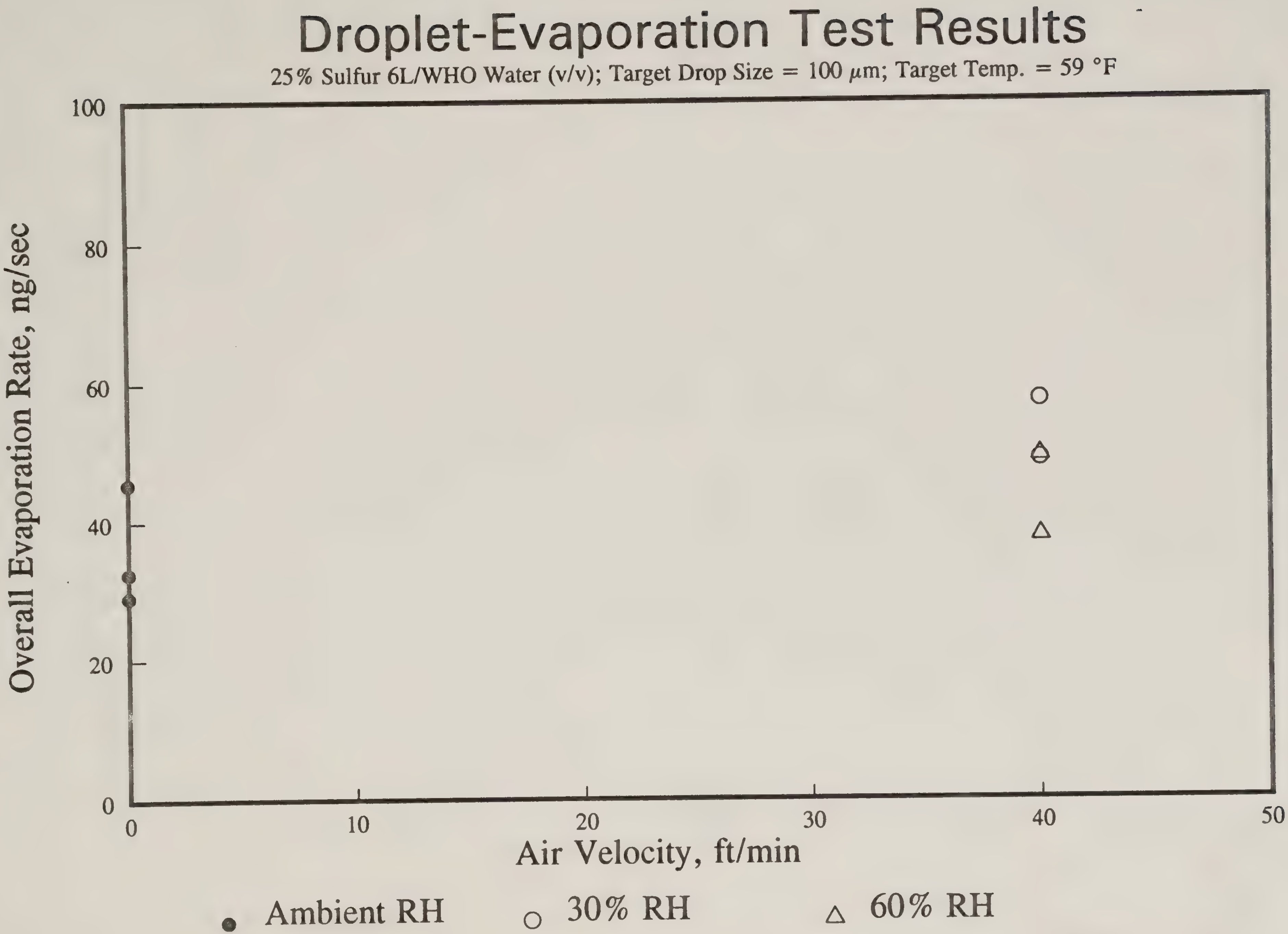
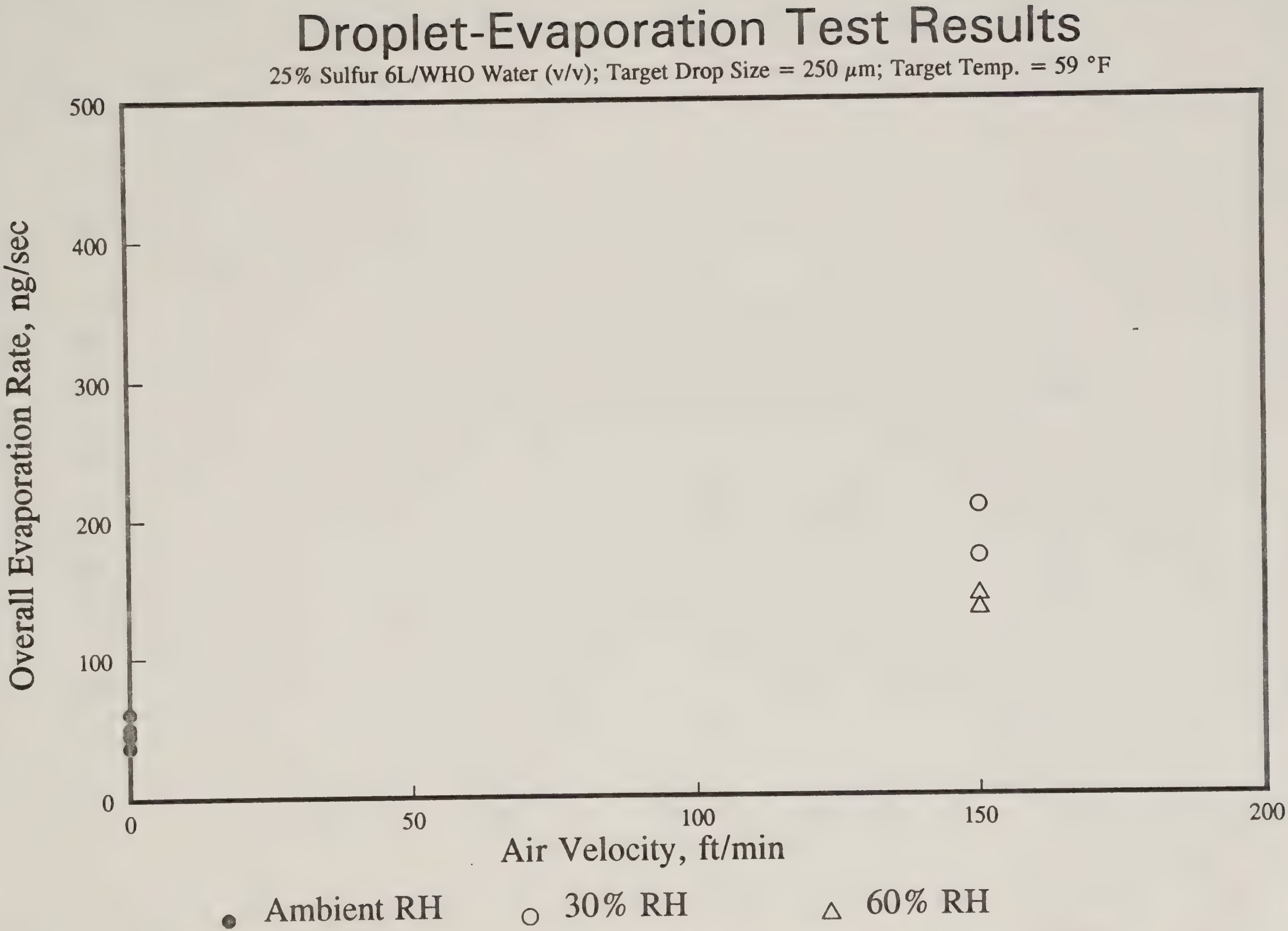

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 100 μm; Target Temp. = 59 °F
Overall Evaporation Rate, ng/sec
100
80
60
40
20
0
0
10
20
30
40
50
Air Velocity, ft/min
Ambient RH
30% RH
60% RH

Figure E-14



Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 250 μm; Target Temp. = 59 °F
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH

Figure E-15

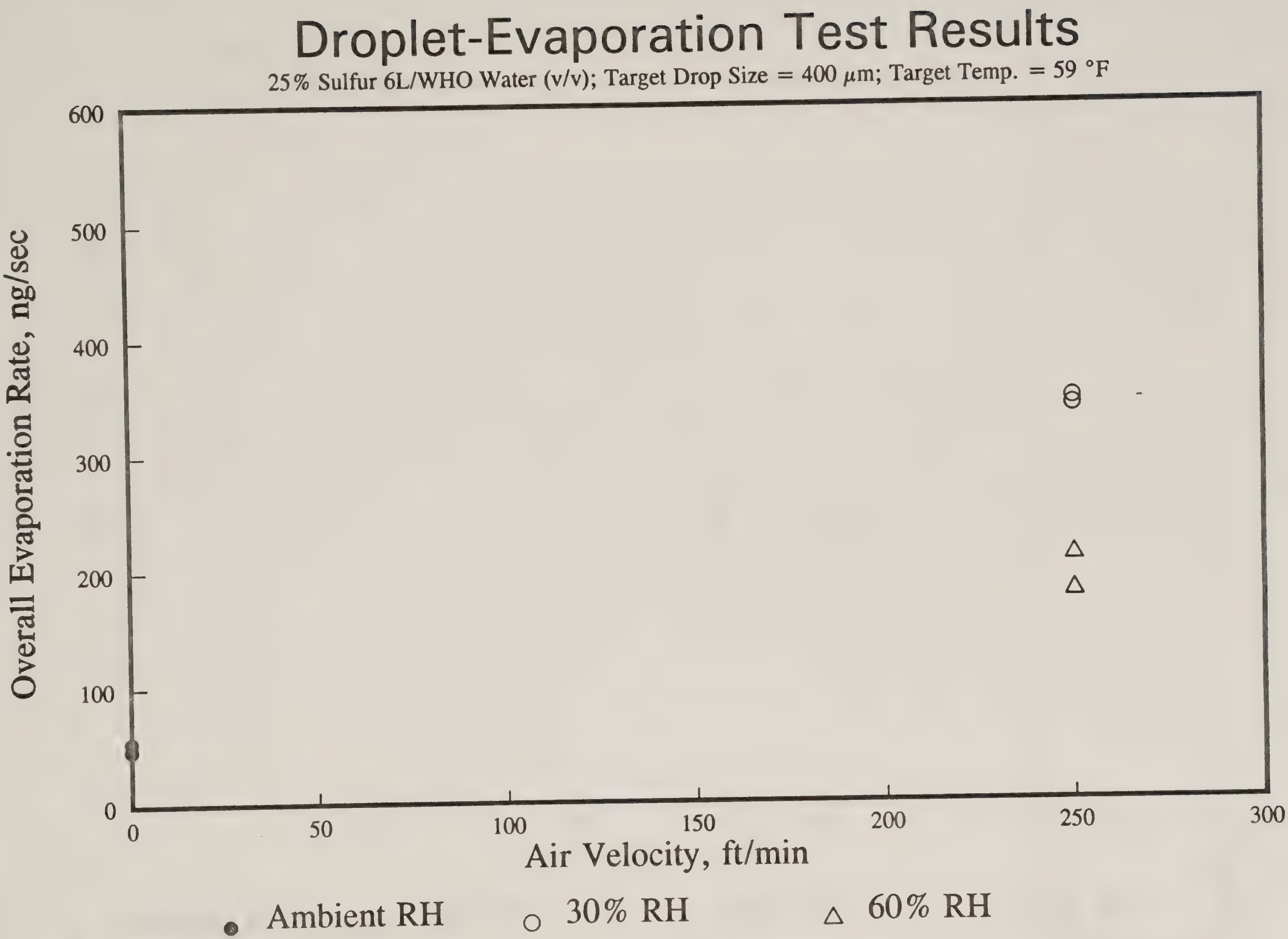

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Drop Size = 400 μm; Target Temp. = 59 °F
Overall Evaporation Rate, ng/sec
600
500
400
300
200
100
0
0
50
100
150
200
250
300
Air Velocity, ft/min
Ambient RH
30% RH
60% RH

Figure E-16

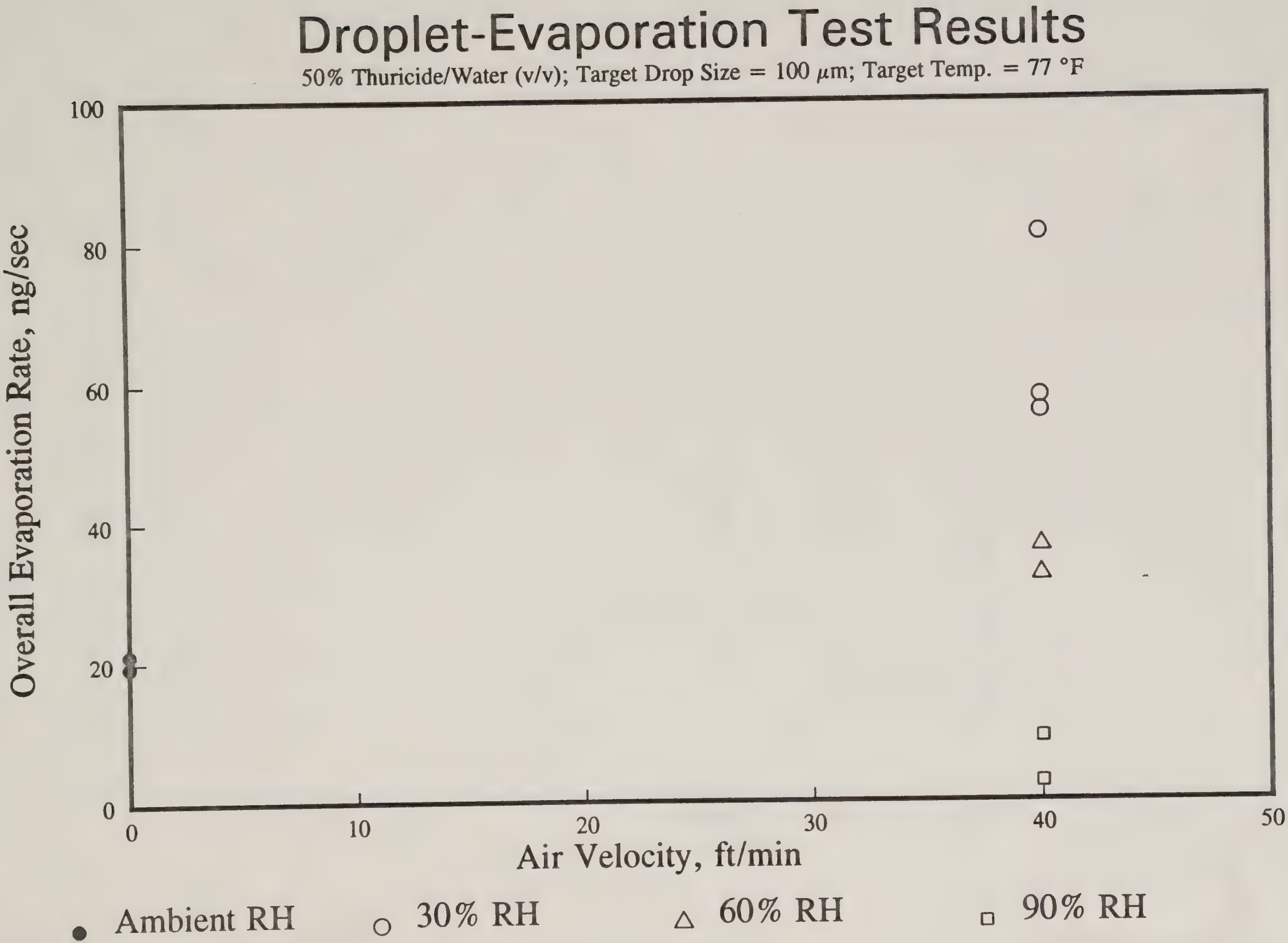
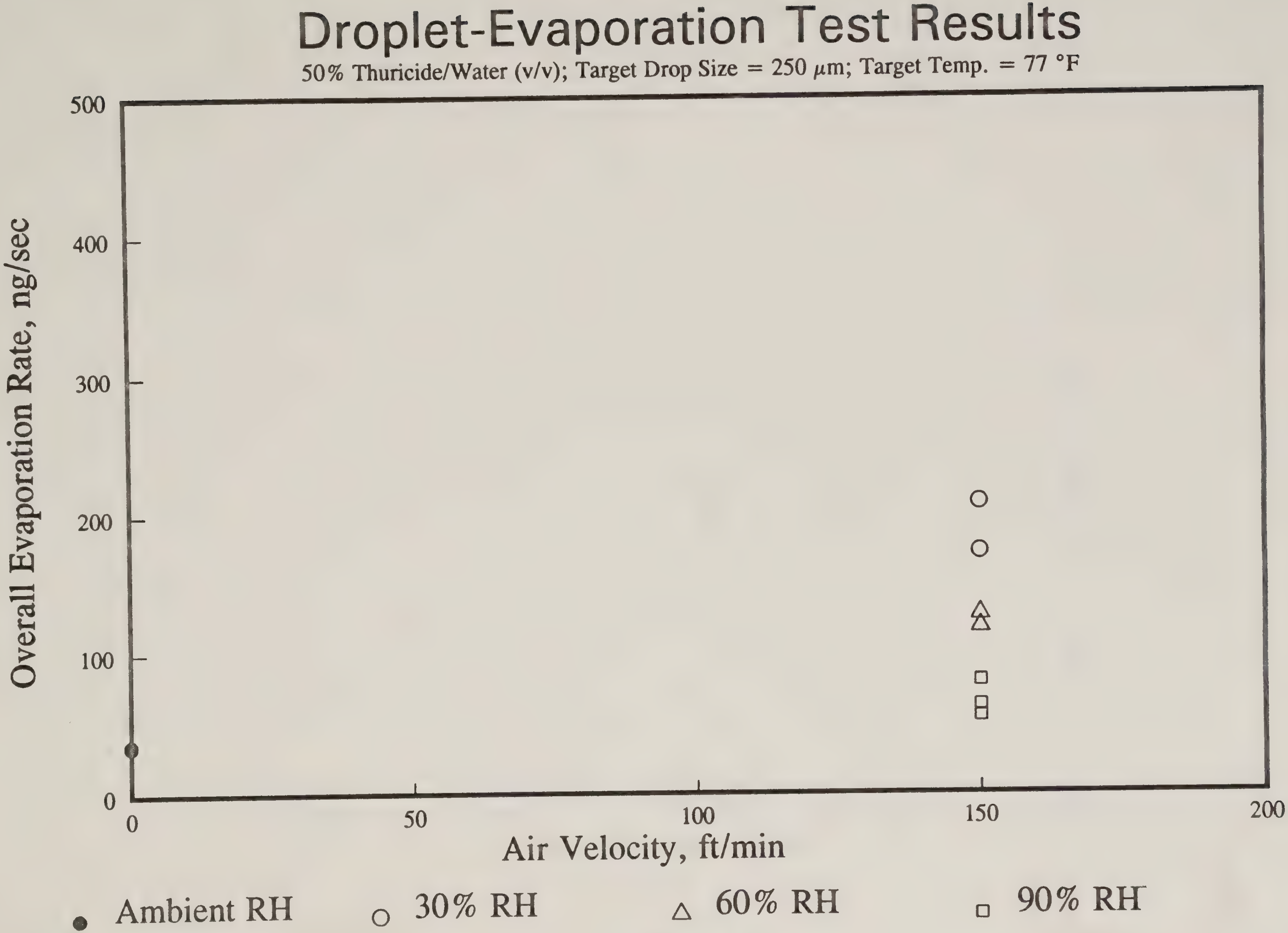
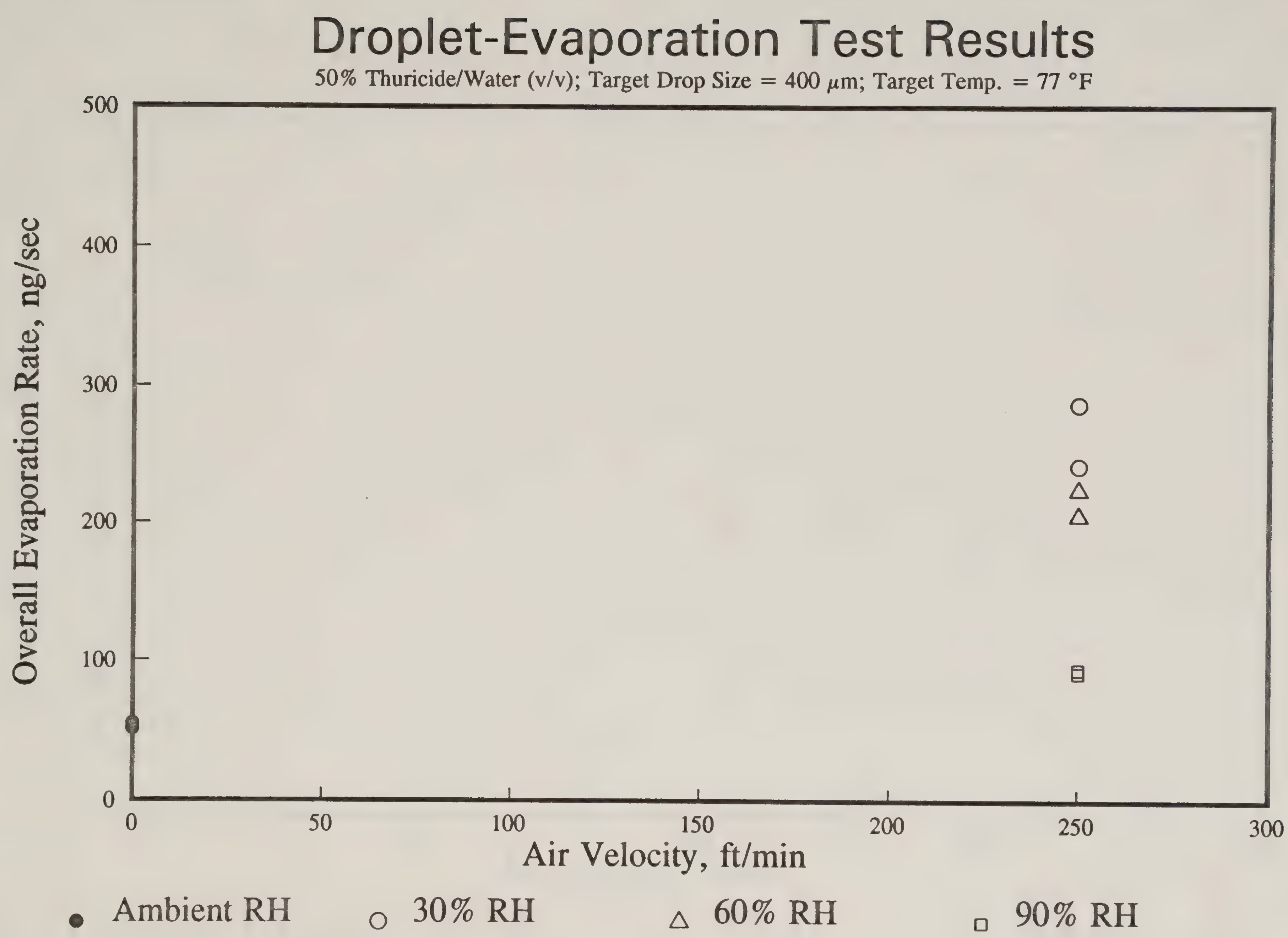

Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 100 μm; Target Temp. = 77 °F
Overall Evaporation Rate, ng/sec
100
80
60
40
20
0
0
10
20
30
40
50
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-17



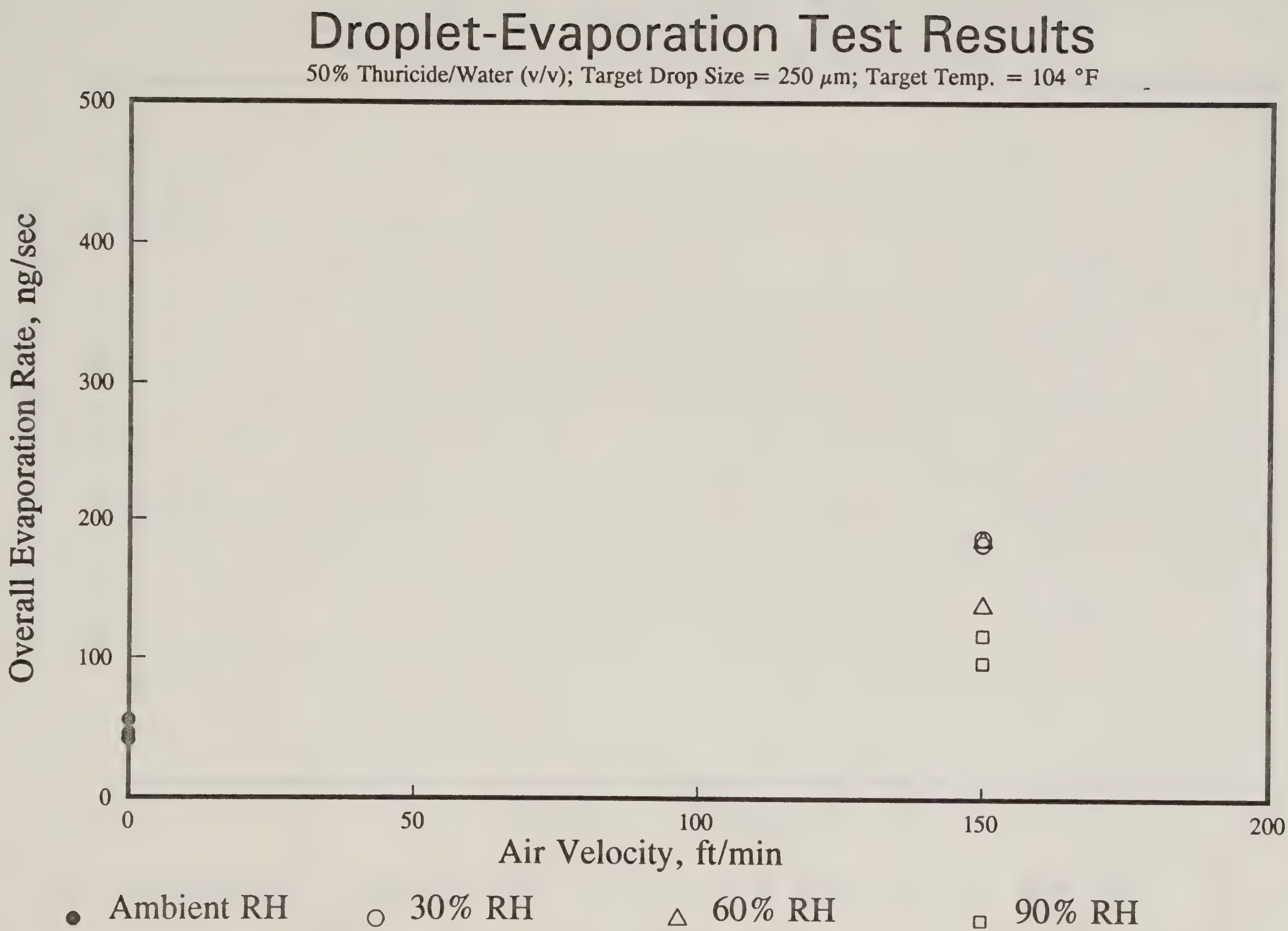
Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 250 μm; Target Temp. = 77 °F
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-18



Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 400 μm; Target Temp. = 77 °F
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
50
100
150
200
250
300
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-19



Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 250 μm; Target Temp. = 104 °F
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH
90% RH

Figure E-20

Droplet-Evaporation Test Results

50% Thuricide/Water (v/v); Target Drop Size = 400 μm; Target Temp. = 104 °F

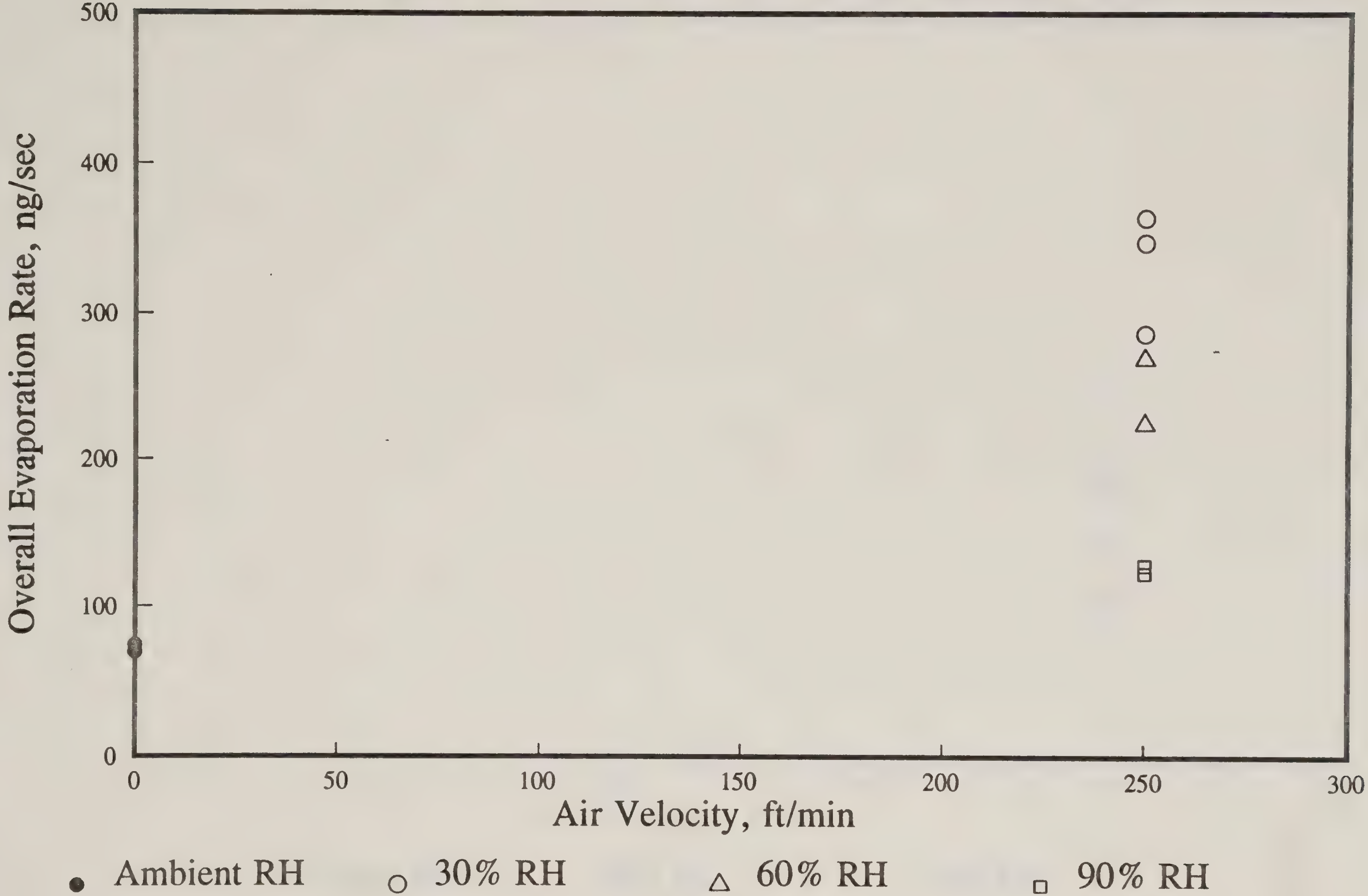


Figure E-21

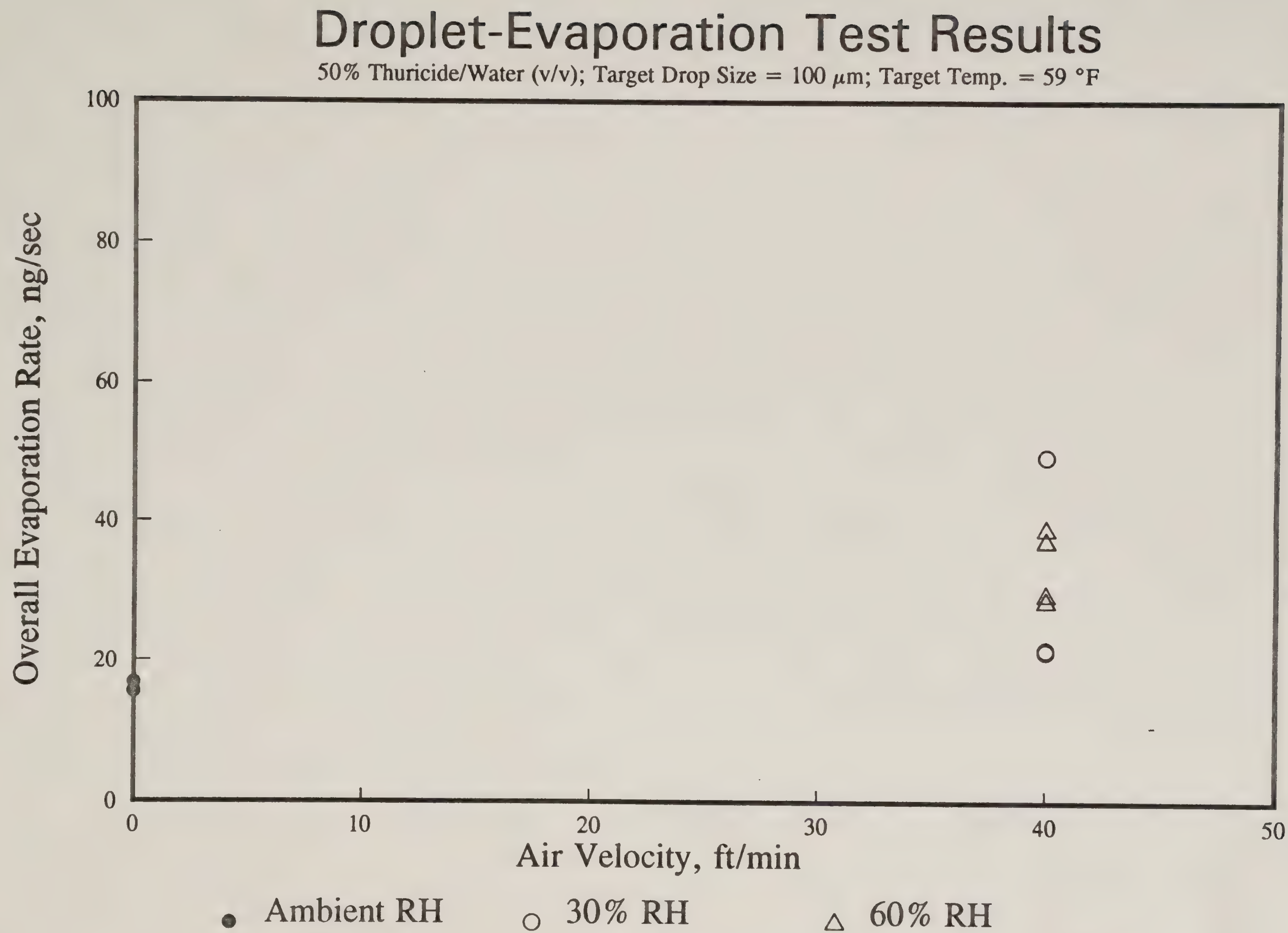

Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 100 μm; Target Temp. = 59 °F
Overall Evaporation Rate, ng/sec
100
80
60
40
20
0
0
10
20
30
40
50
Air Velocity, ft/min
Ambient RH
30% RH
60% RH

Figure E-22

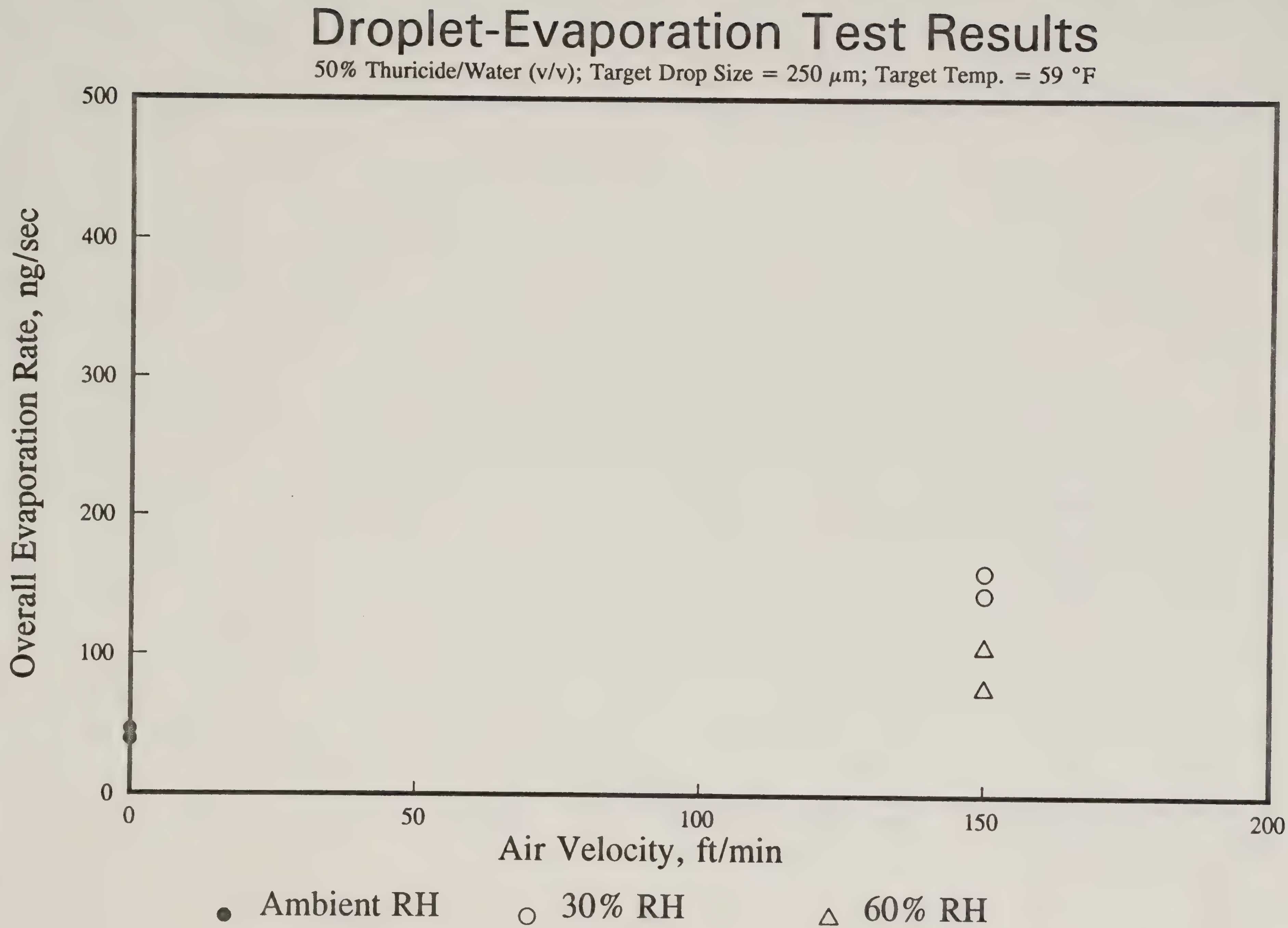

Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Drop Size = 250 μm; Target Temp. = 59 °F
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
50
100
150
200
Air Velocity, ft/min
Ambient RH
30% RH
60% RH

Figure E-23

Droplet-Evaporation Test Results

50% Thuricide/Water (v/v); Target Drop Size = 400 μm; Target Temp. = 59 °F

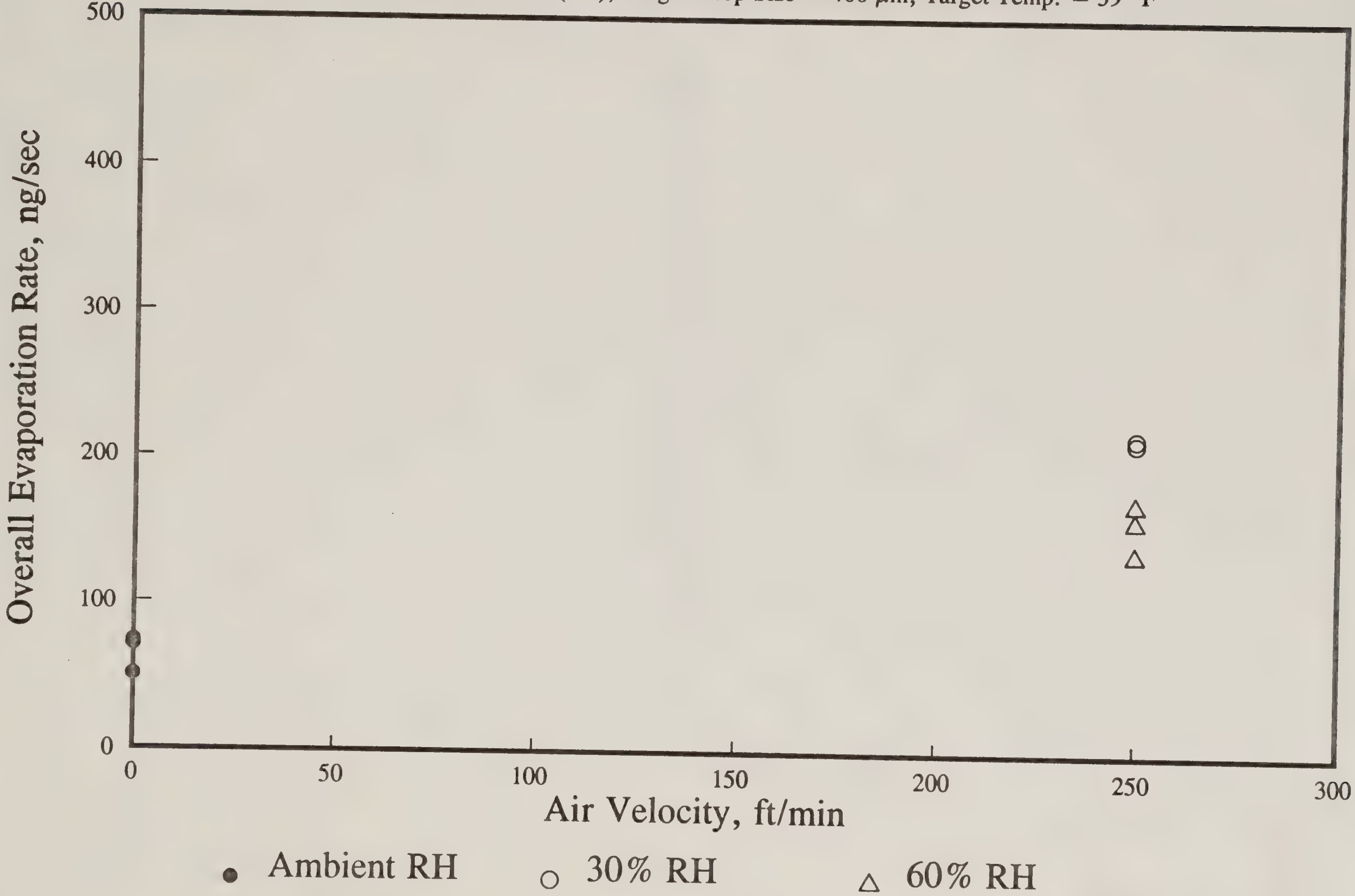


Figure E-24

APPENDIX F

PLOTTED RESULTS OF THE DROPLET-EVAPORATION TESTS -- OVERALL EVAPORATION RATE VERSUS EXPERIMENTAL DROP SIZE

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 77 °F; Target RH = 30%

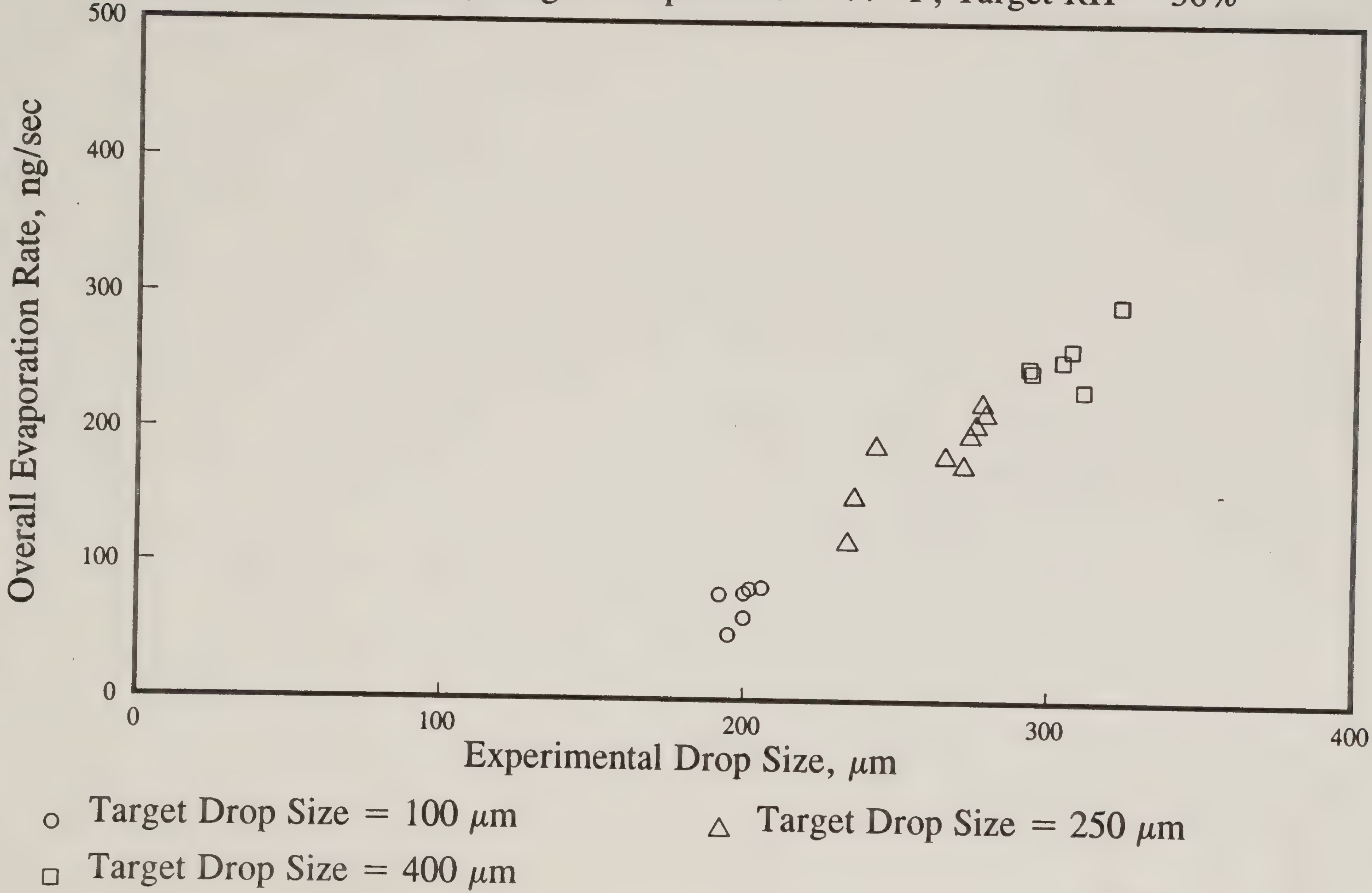


Figure F-1

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 77 °F; Target RH = 60%

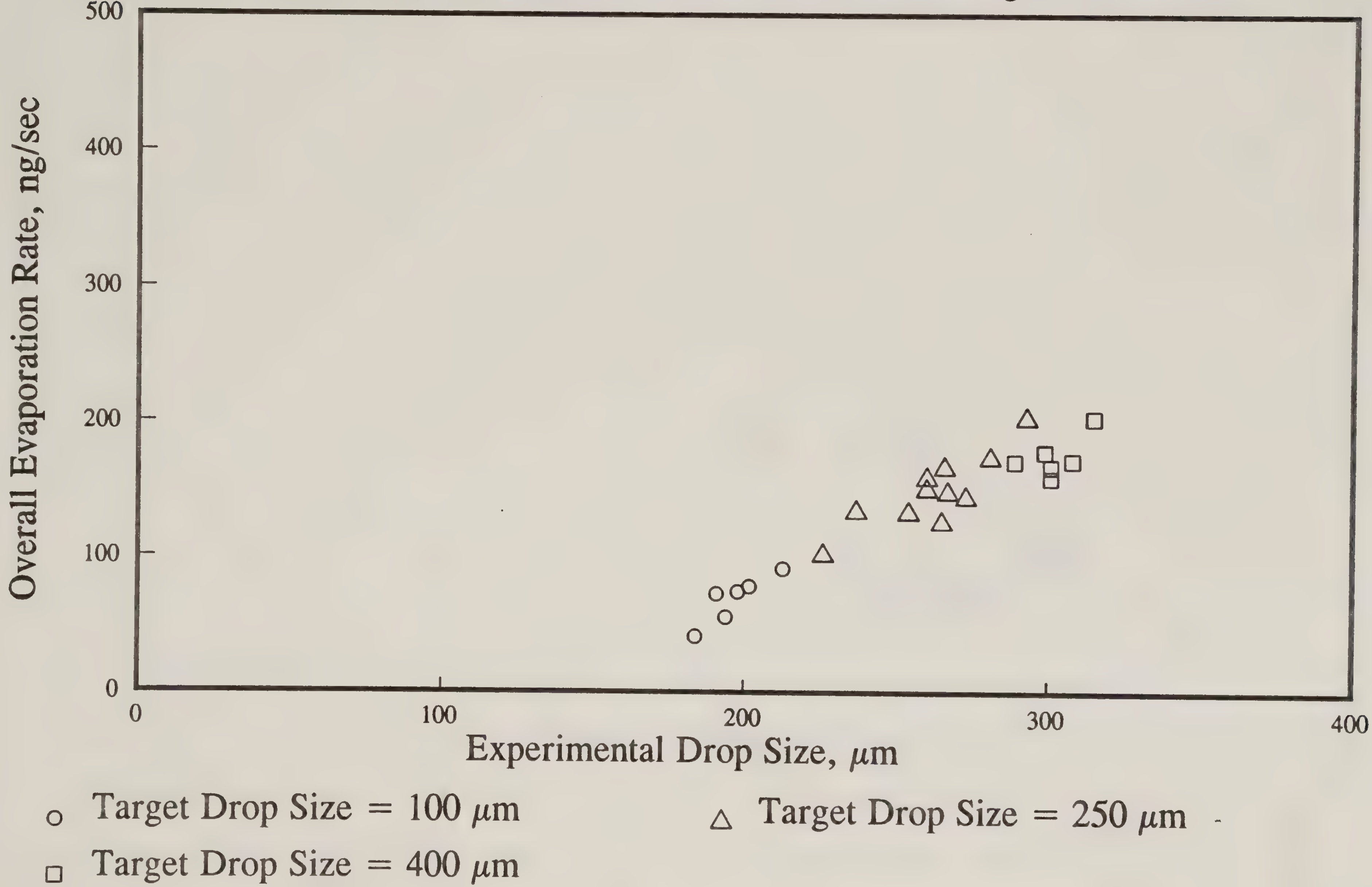


Figure F-2

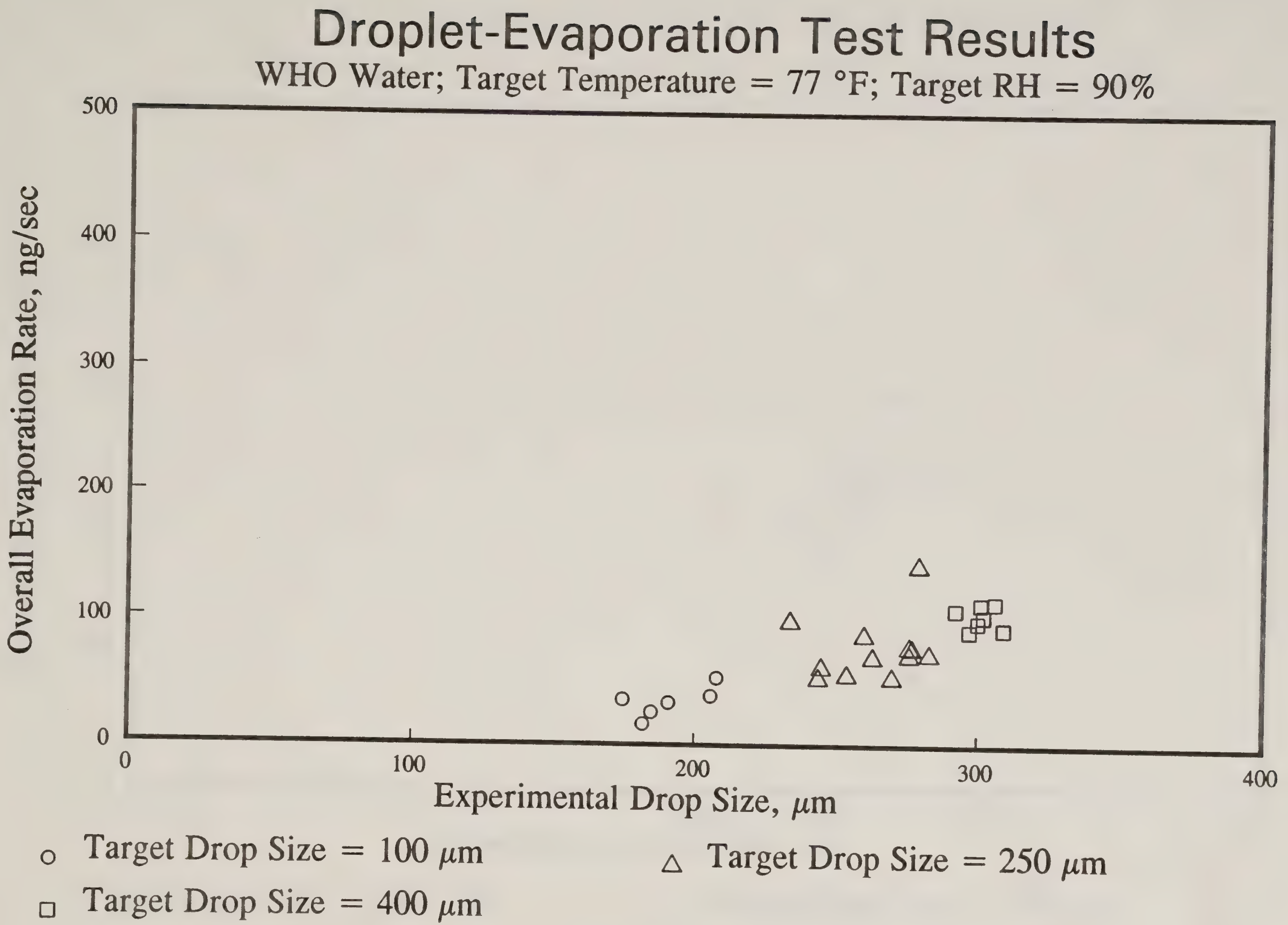

Droplet-Evaporation Test Results
WHO Water; Target Temperature = 77 °F; Target RH = 90%
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
100
200
300
400
Experimental Drop Size, μm
Target Drop Size = 100 μm
Target Drop Size = 250 μm
Target Drop Size = 400 μm

Figure F-3

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 104 °F; Target RH = 30%

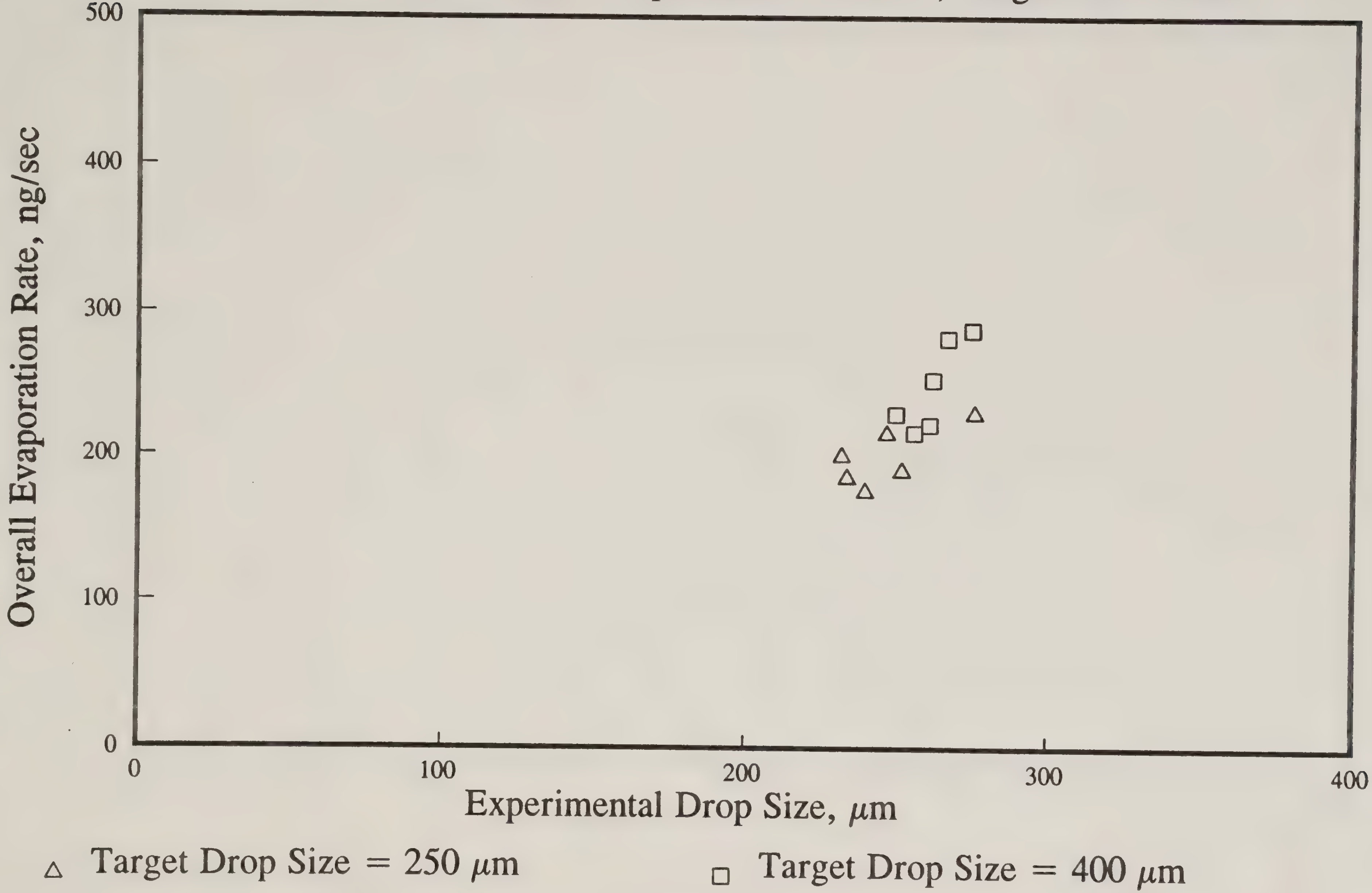


Figure F-4

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 104 °F; Target RH = 60%

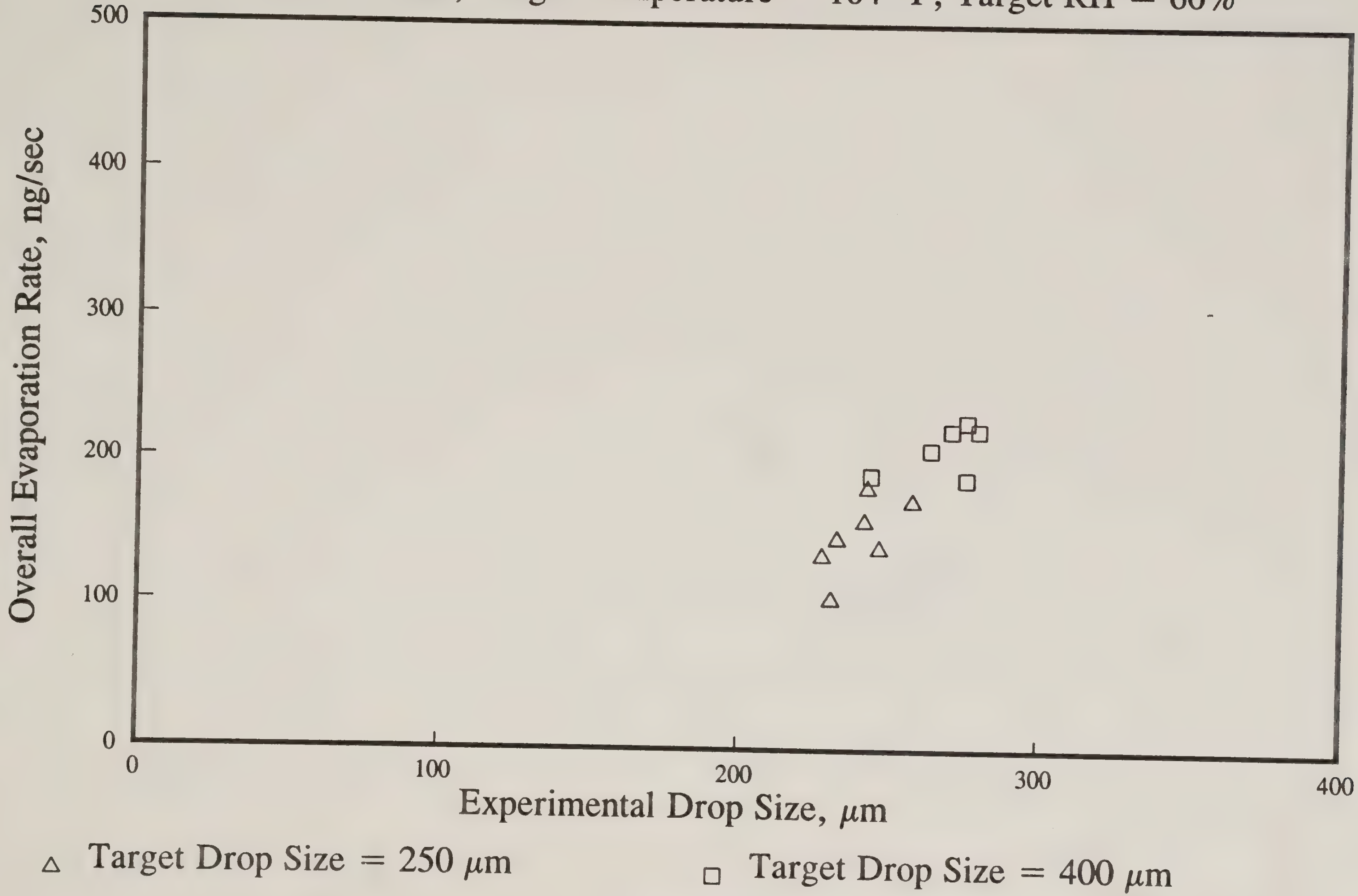


Figure F-5

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 104 °F; Target RH = 90%

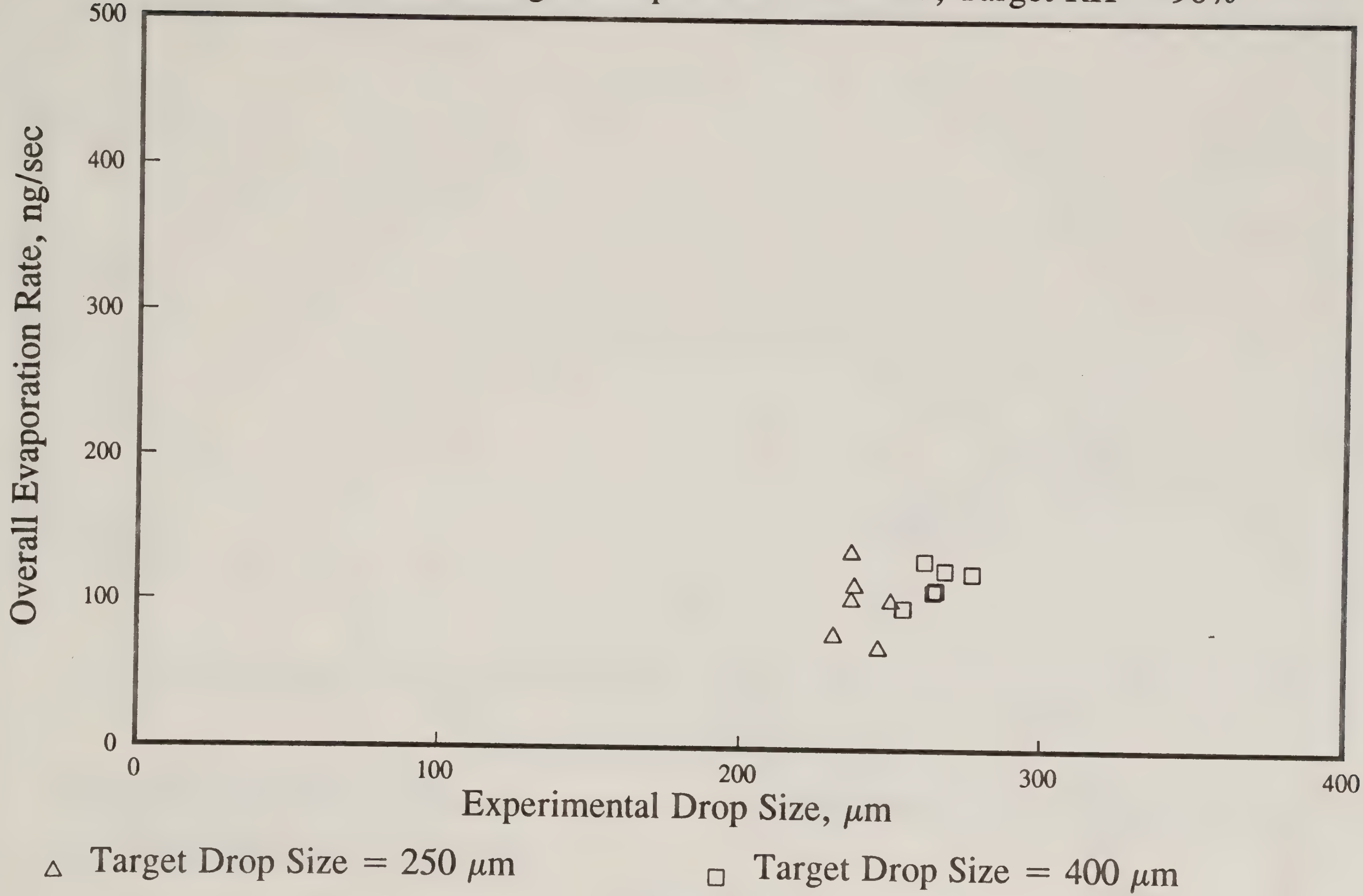


Figure F-6

Droplet-Evaporation Test Results

WHO Water; Target Temperature = 59 °F; Target RH = 30%

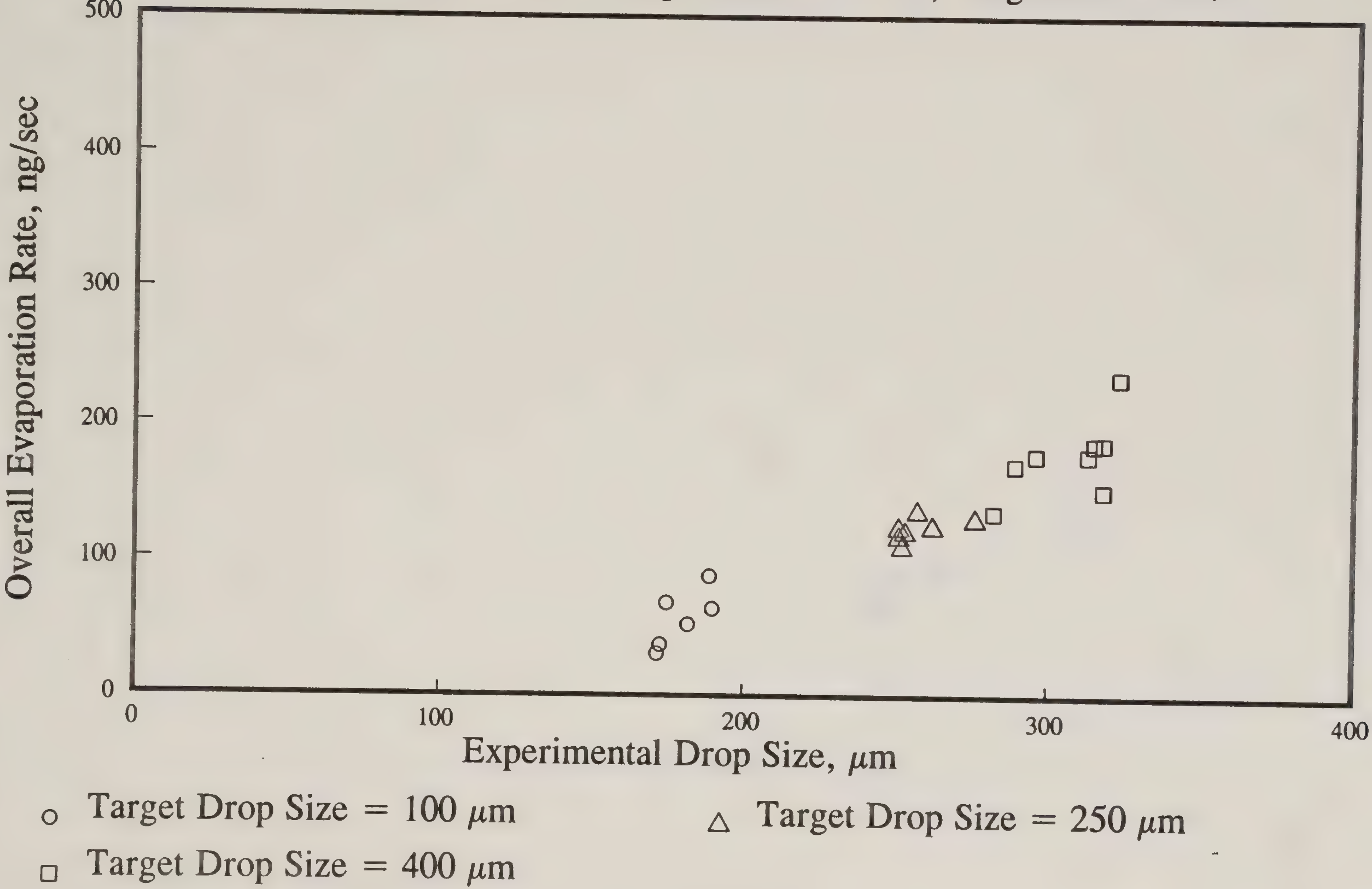
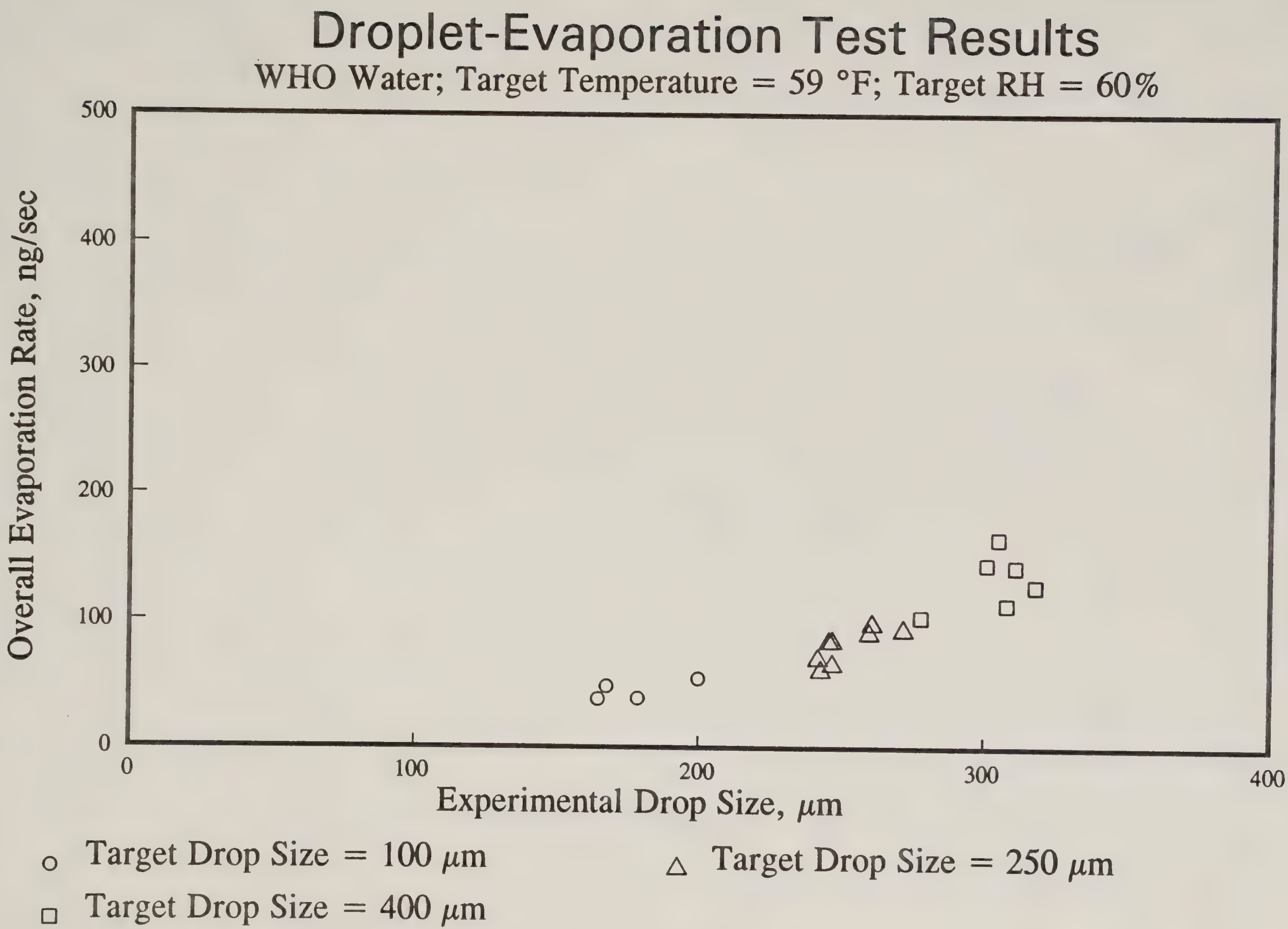


Figure F-7



Droplet-Evaporation Test Results
WHO Water; Target Temperature = 59 °F; Target RH = 60%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
○ Target Drop Size = 100 μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-8

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Temp. = 77 °F; Target RH = 30%

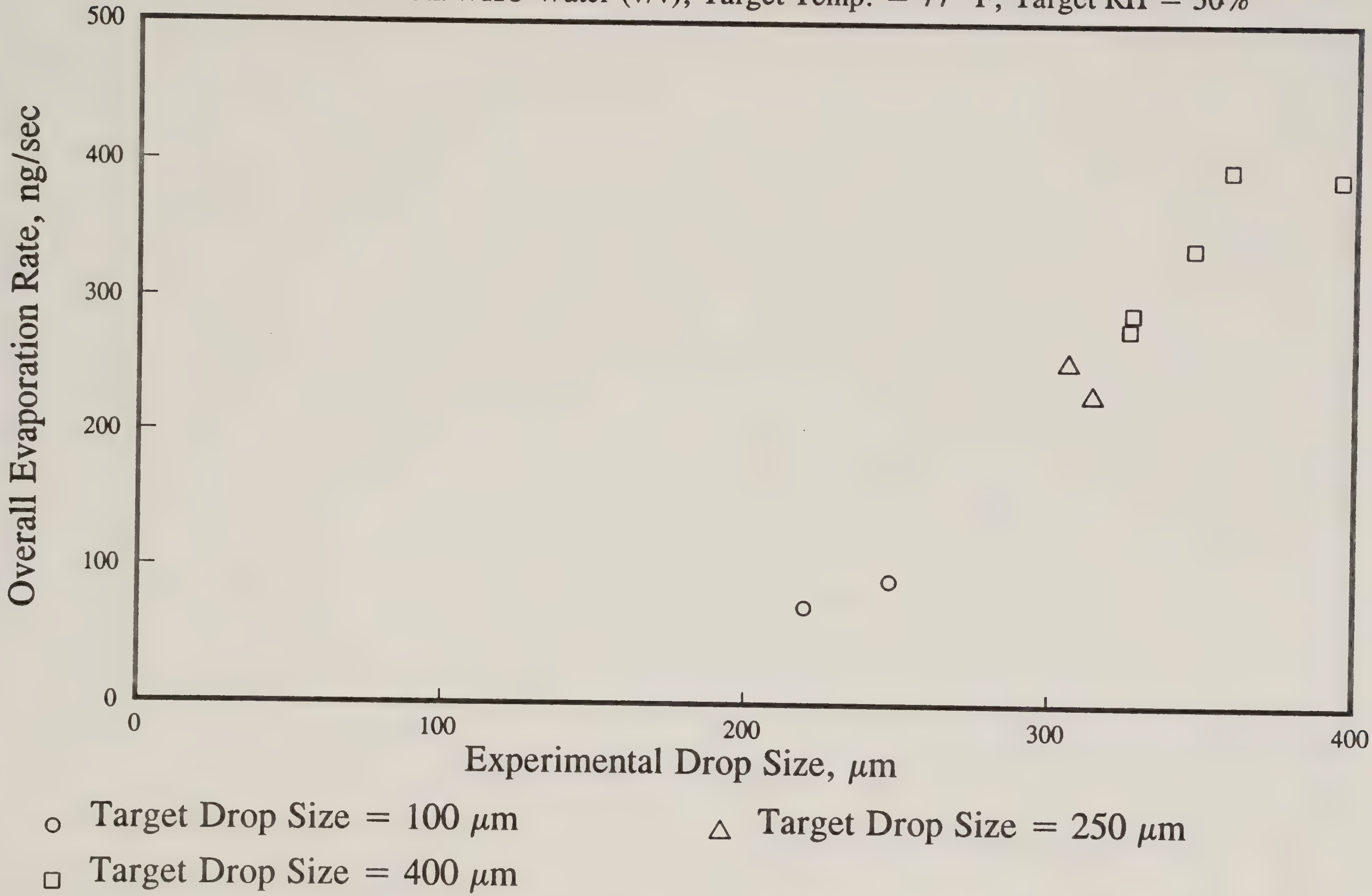
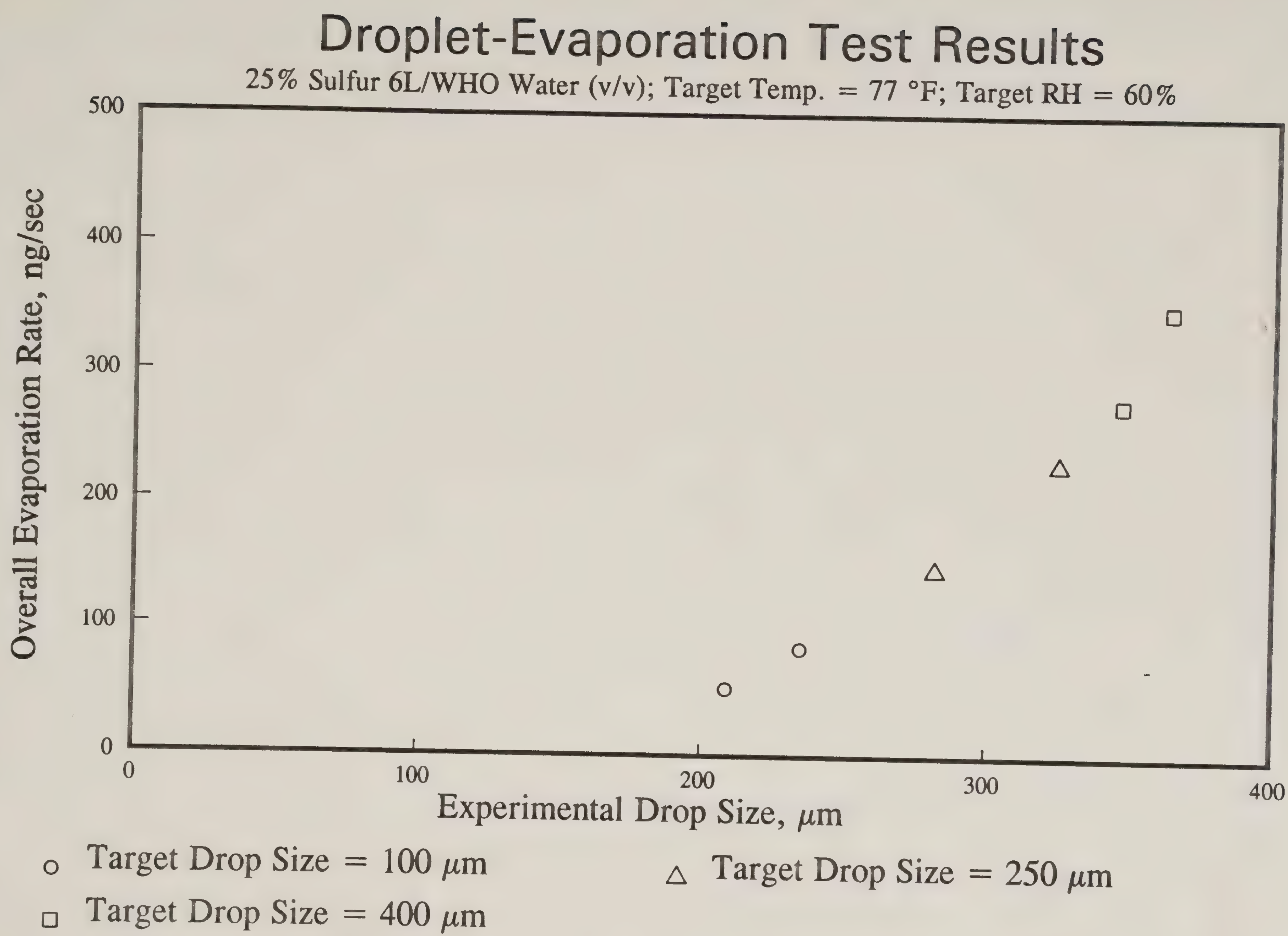


Figure F-9



Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Temp. = 77 °F; Target RH = 60%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
Target Drop Size = 100 μm
Target Drop Size = 250 μm
Target Drop Size = 400 μm

Figure F-10

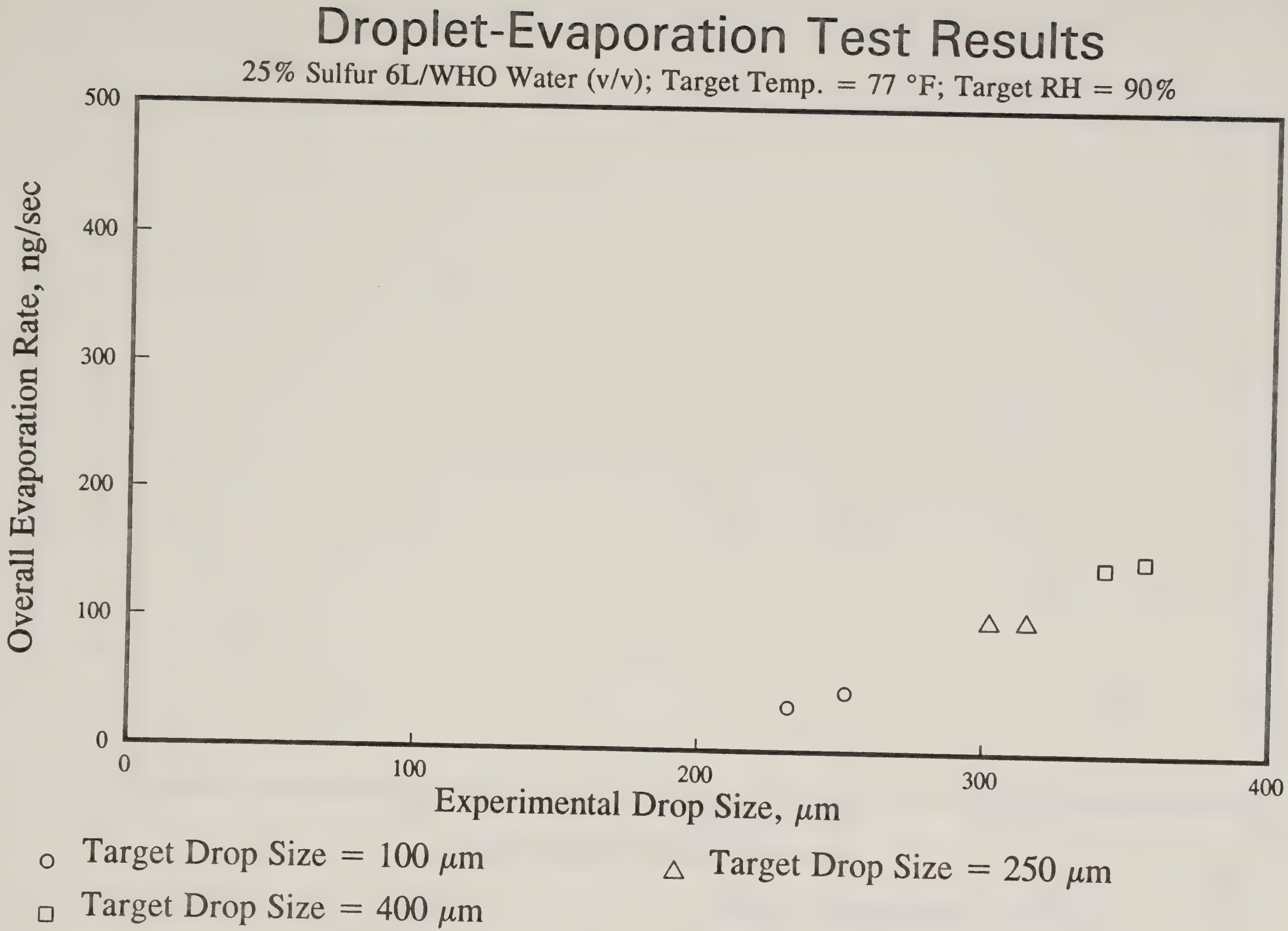
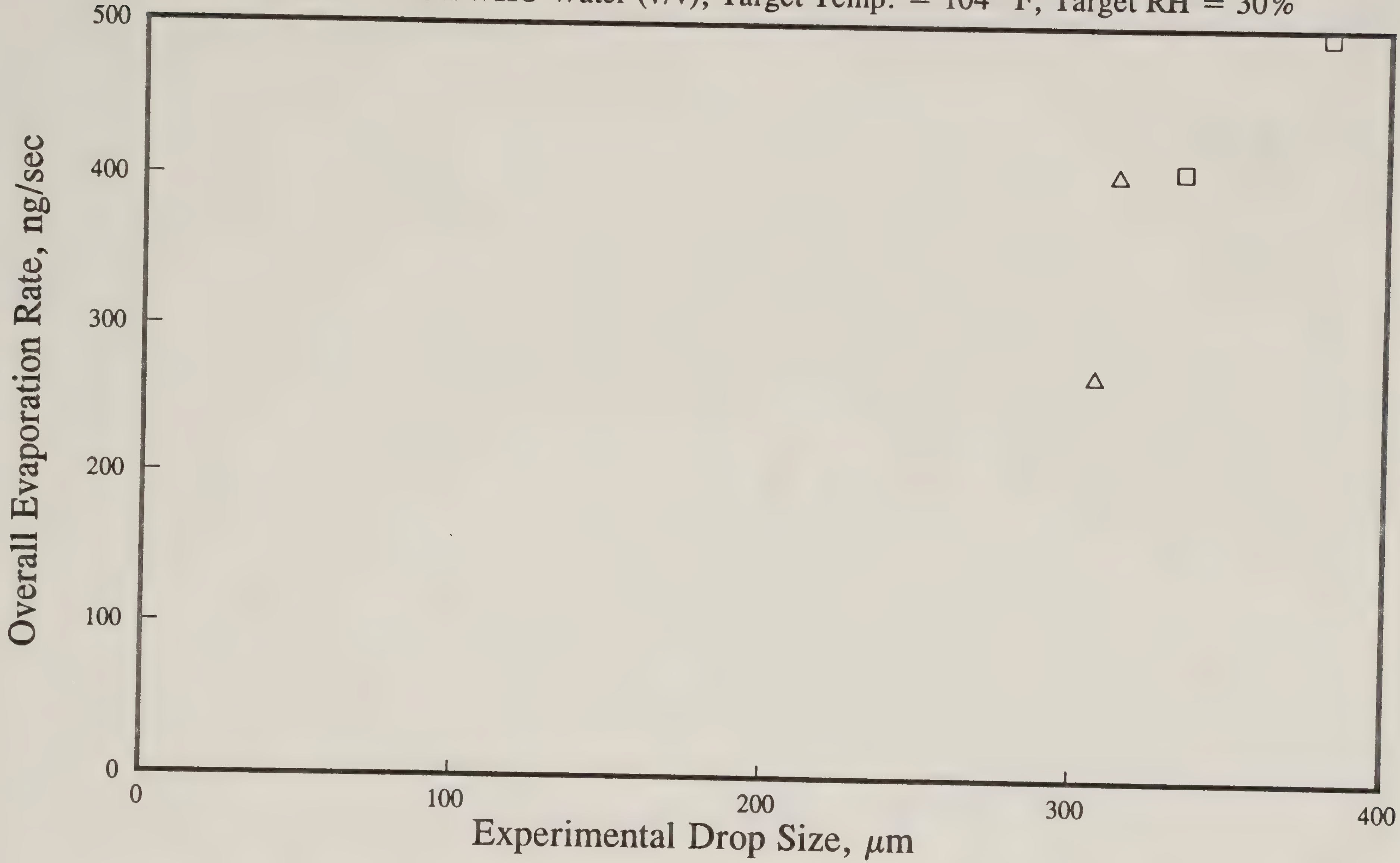

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Temp. = 77 °F; Target RH = 90%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
Target Drop Size = 100 μm
Target Drop Size = 250 μm
Target Drop Size = 400 μm

Figure F-11

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Temp. = 104 °F; Target RH = 30%



△ Target Drop Size = 250 μm   □ Target Drop Size = 400 μm

Figure F-12

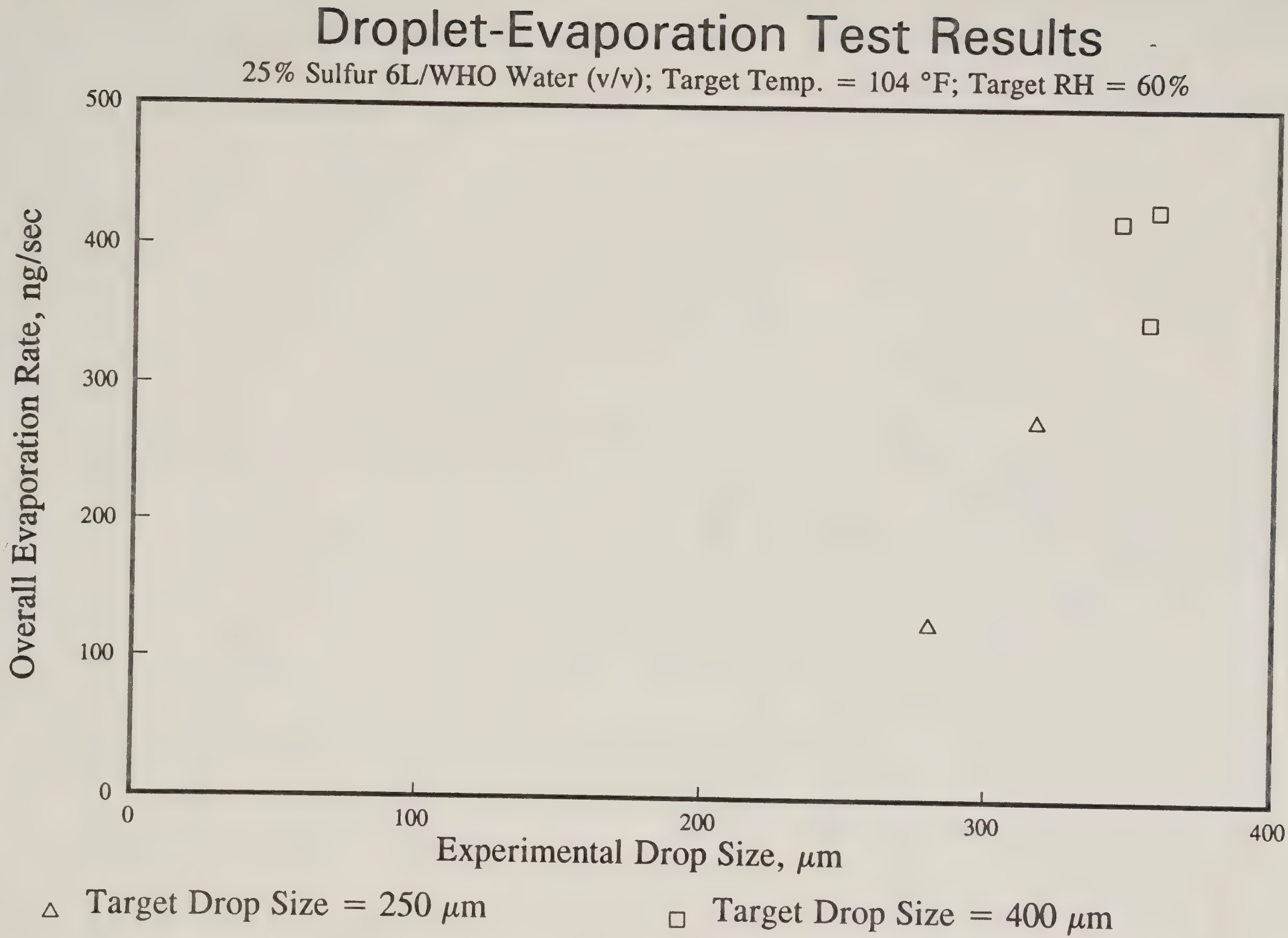

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Temp. = 104 °F; Target RH = 60%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, µm
Target Drop Size = 250 µm
Target Drop Size = 400 µm

Figure F-13

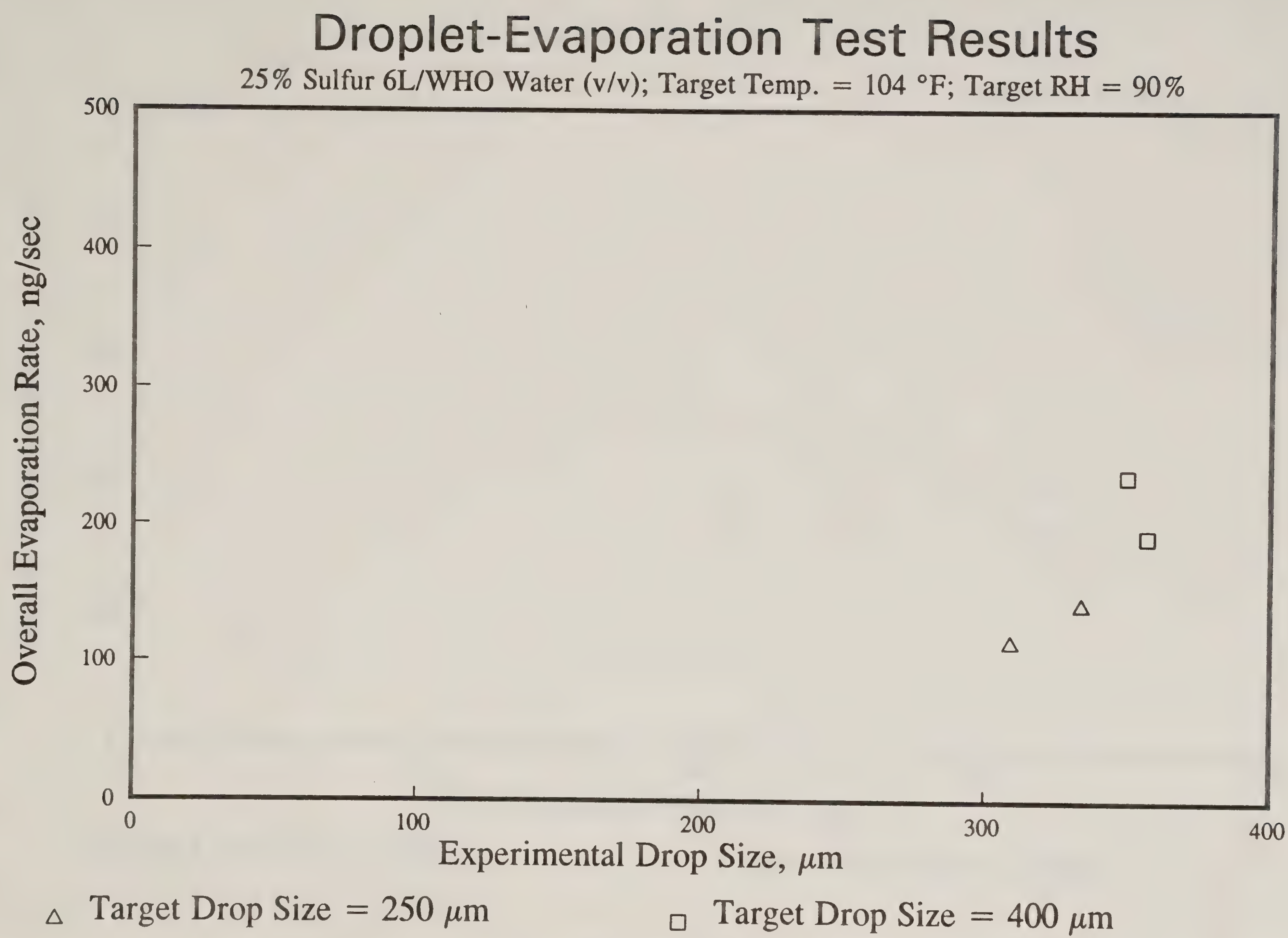
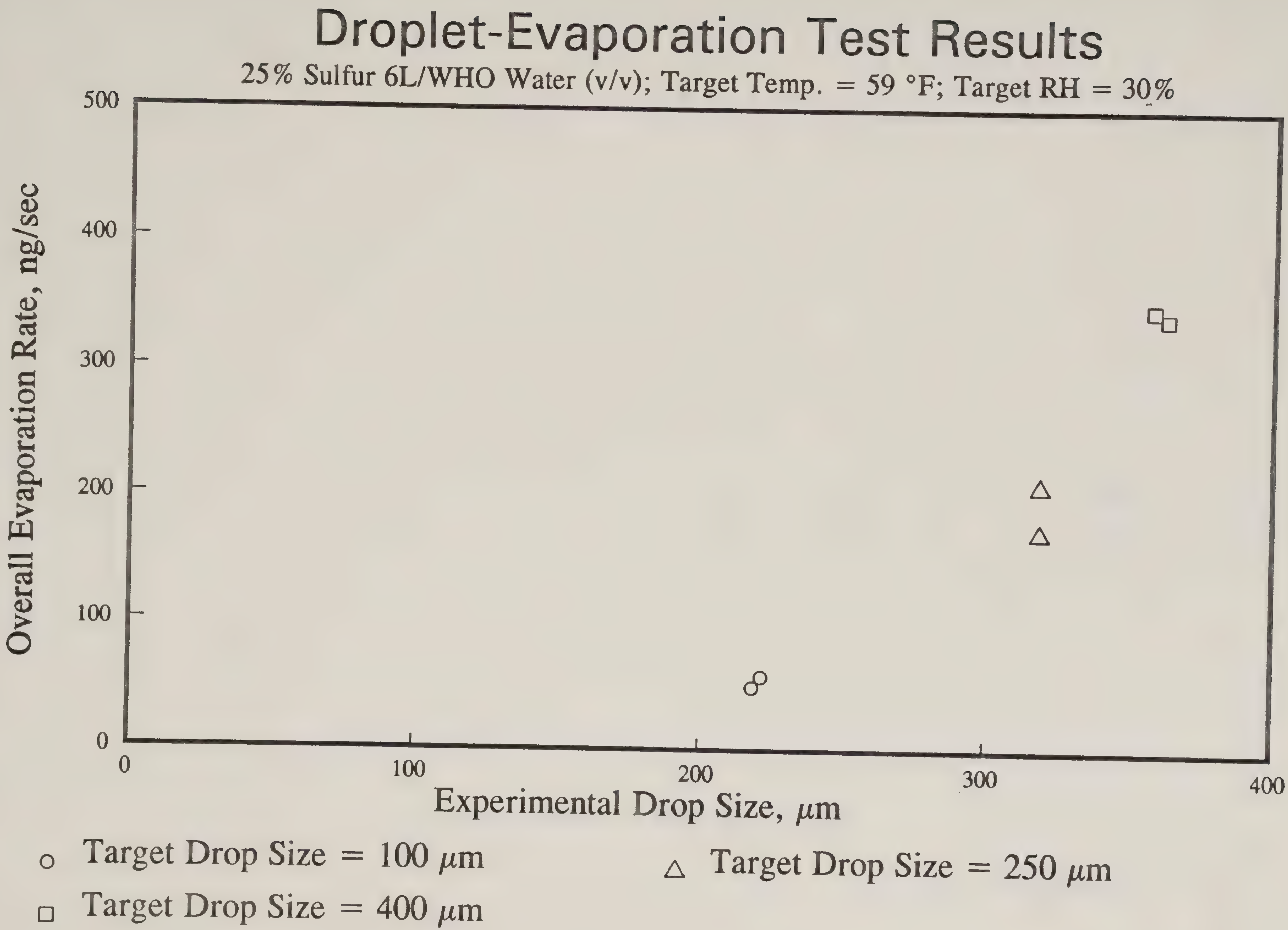

Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Temp. = 104 °F; Target RH = 90%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-14



Droplet-Evaporation Test Results
25% Sulfur 6L/WHO Water (v/v); Target Temp. = 59 °F; Target RH = 30%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
○ Target Drop Size = 100 μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-15

Droplet-Evaporation Test Results

25% Sulfur 6L/WHO Water (v/v); Target Temp. = 59 °F; Target RH = 60%

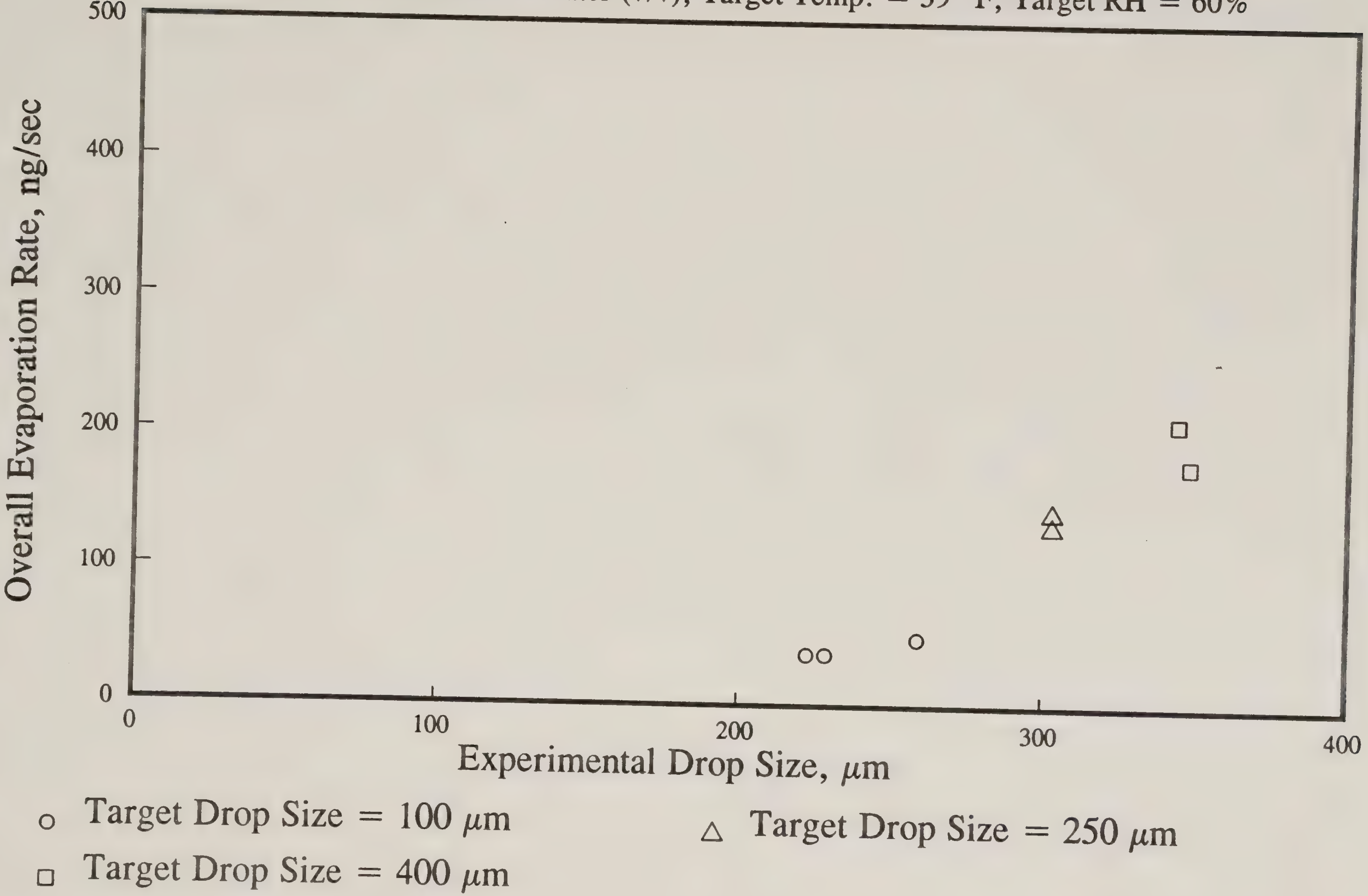
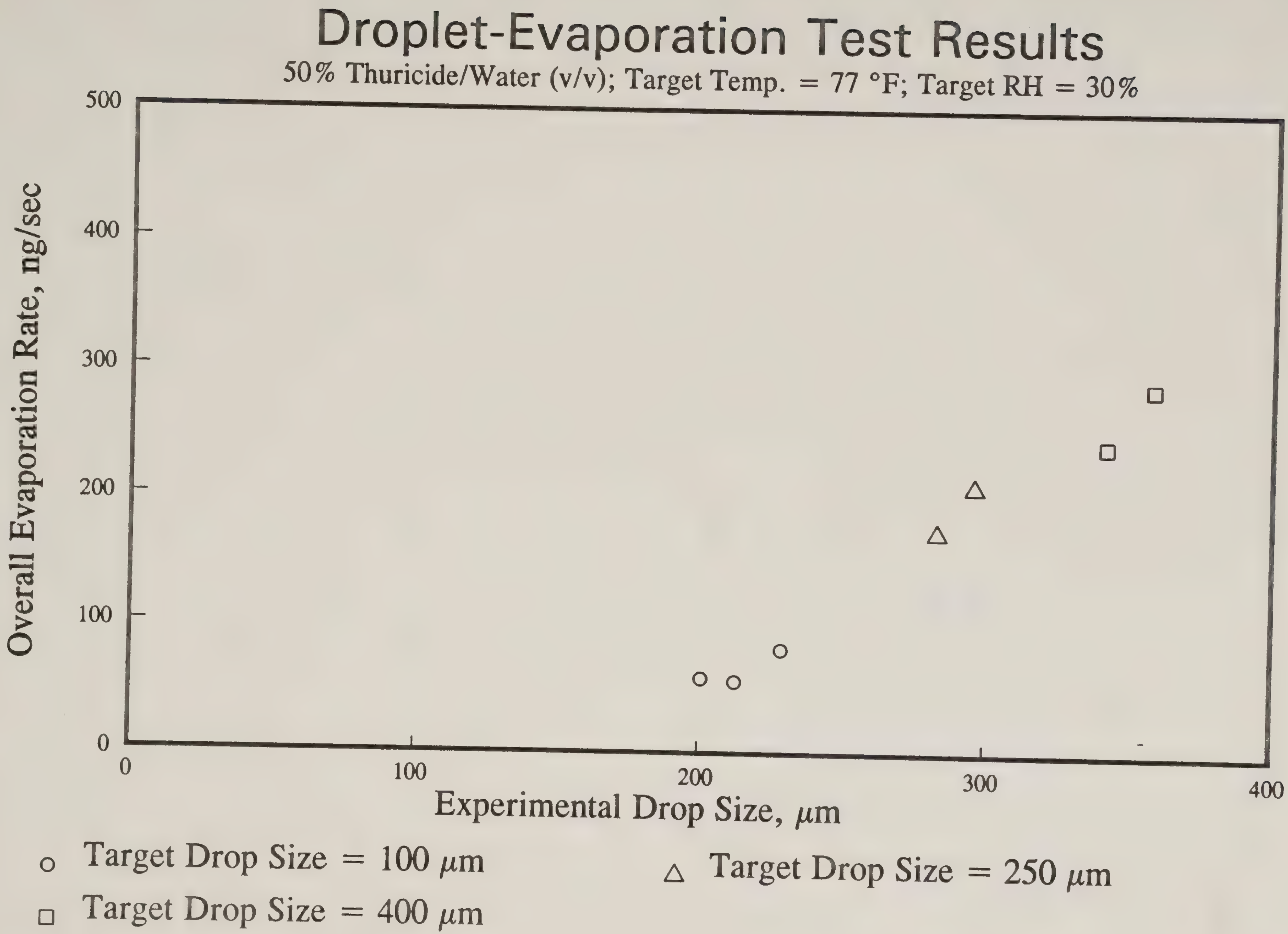
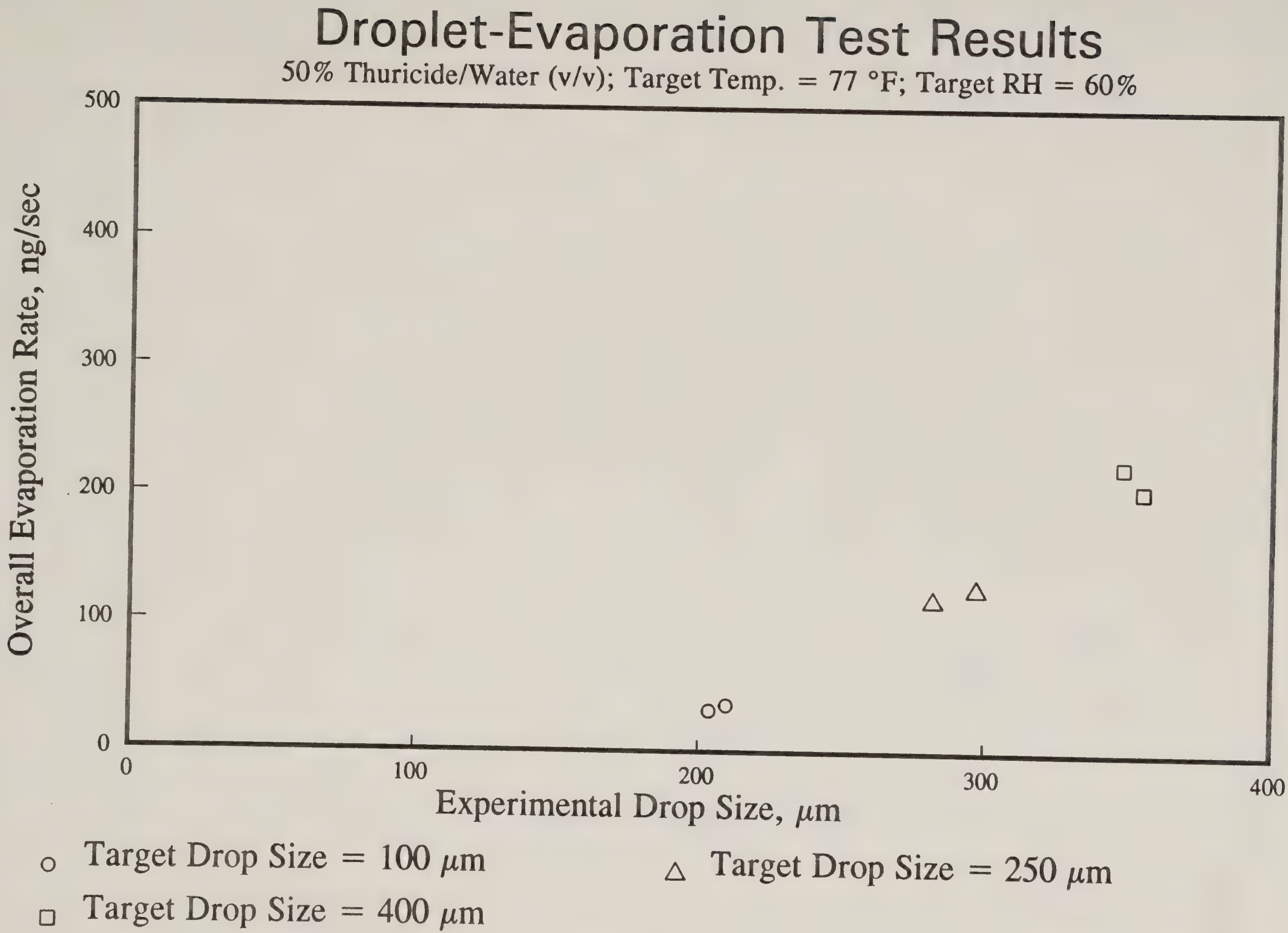


Figure F-16



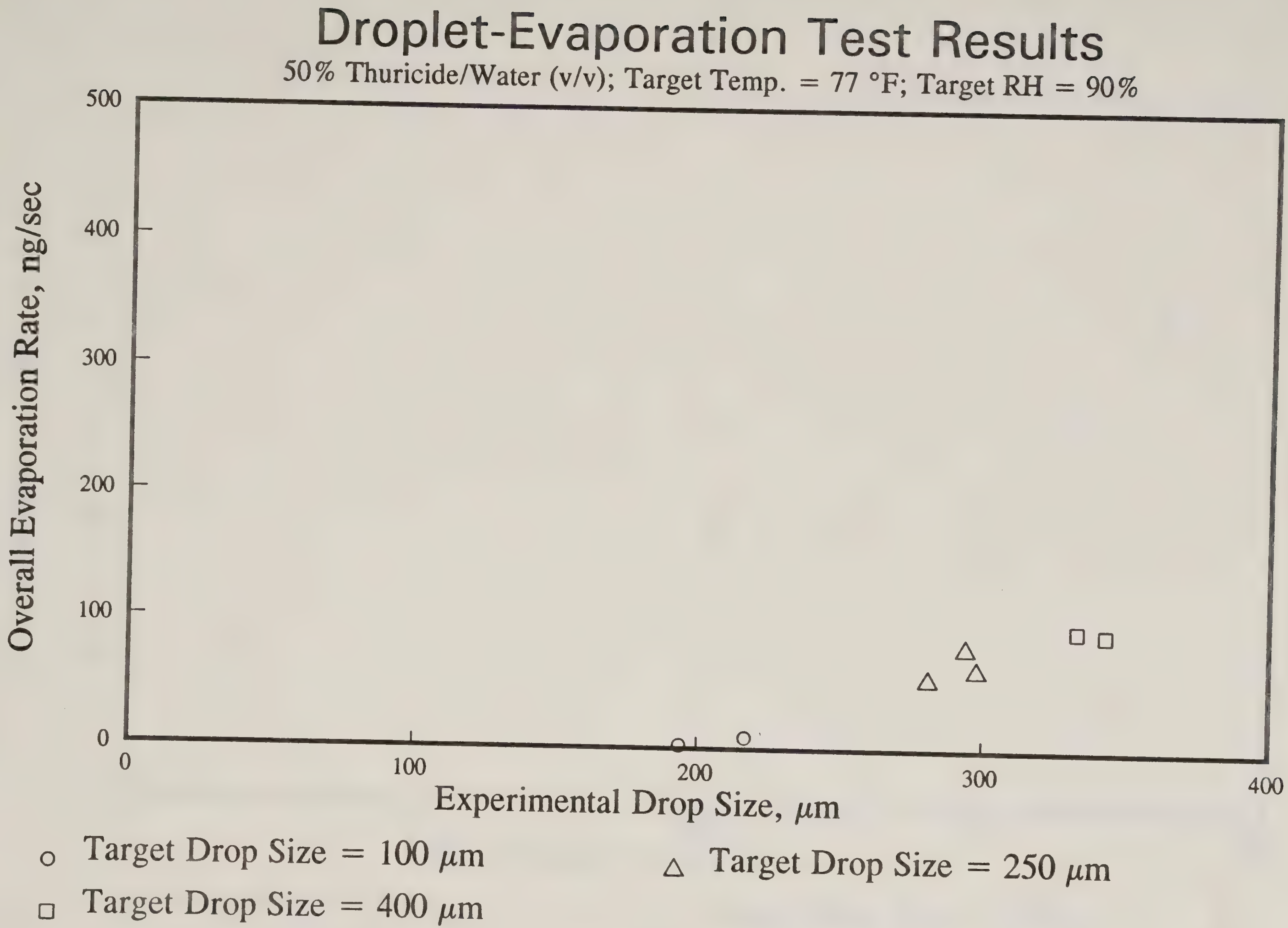
Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 77 °F; Target RH = 30%
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
100
200
300
400
Experimental Drop Size, μm
Target Drop Size = 100 μm
Target Drop Size = 250 μm
Target Drop Size = 400 μm

Figure F-17



Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 77 °F; Target RH = 60%
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
100
200
300
400
Experimental Drop Size, μm
○ Target Drop Size = 100 μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-18



Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 77 °F; Target RH = 90%
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
100
200
300
400
Experimental Drop Size, μm
○ Target Drop Size = 100 μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-19

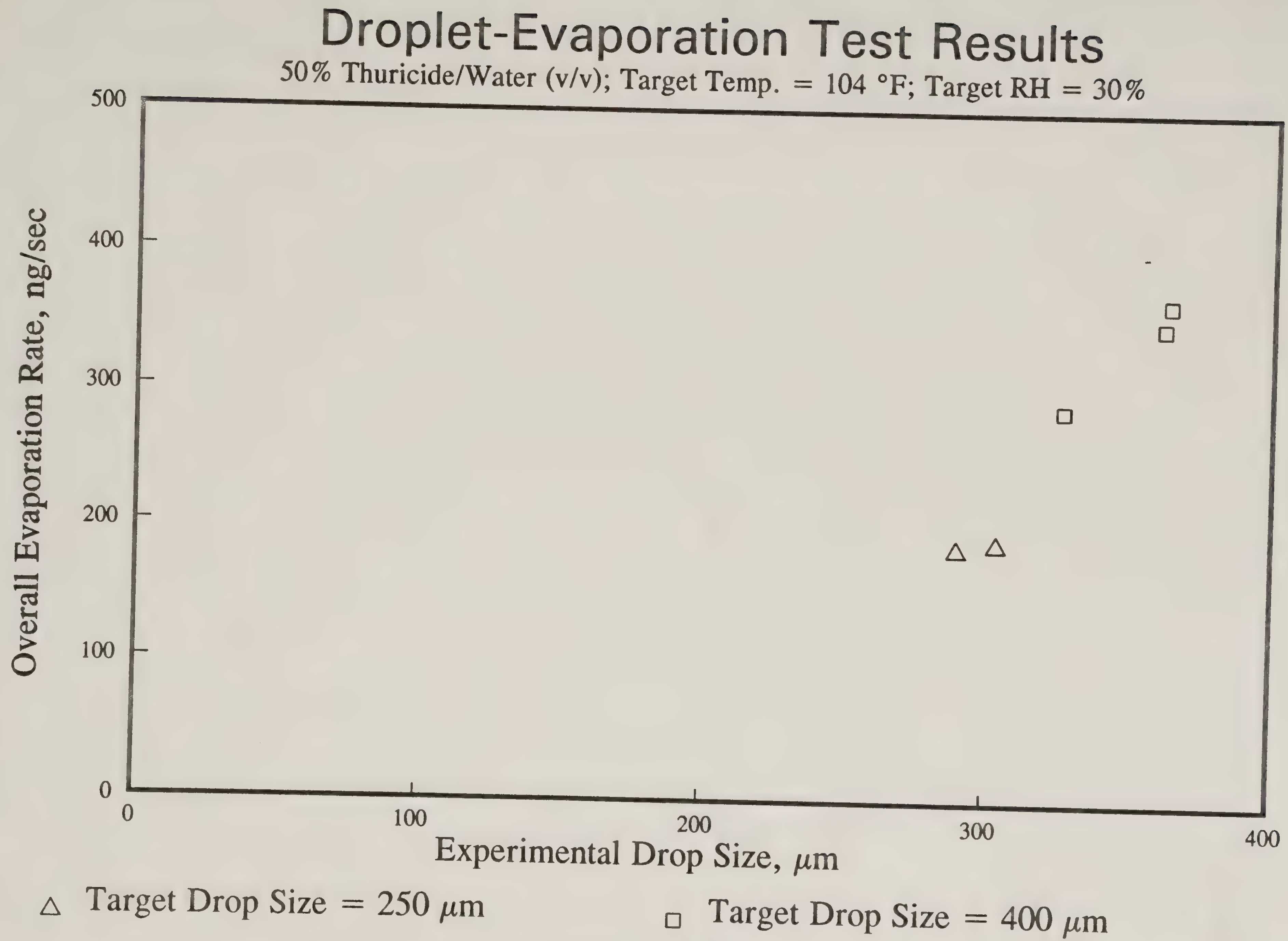

Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 104 °F; Target RH = 30%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-20

Droplet-Evaporation Test Results

50% Thuricide/Water (v/v); Target Temp. = 104 °F; Target RH = 60%

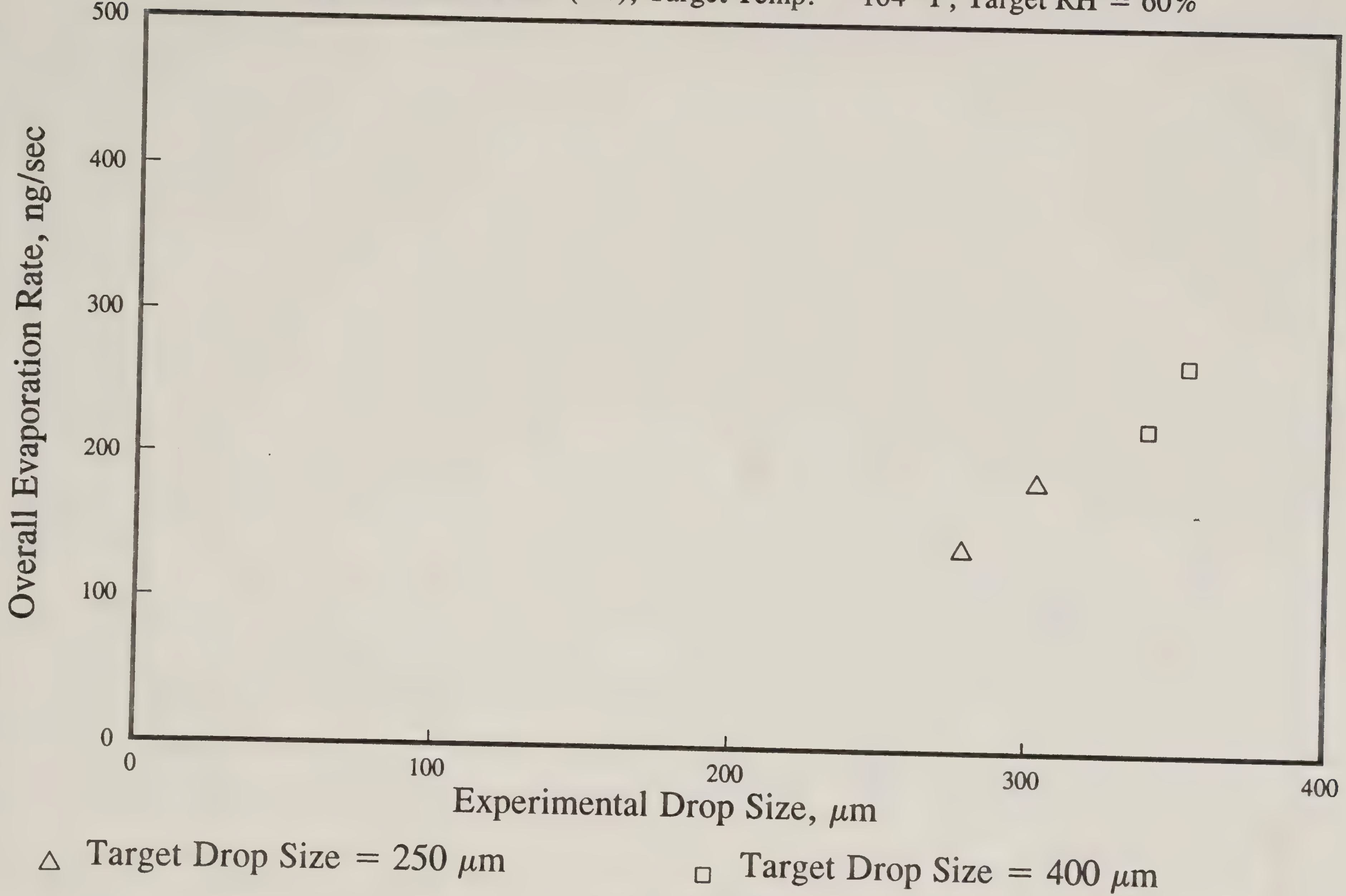


Figure F-21

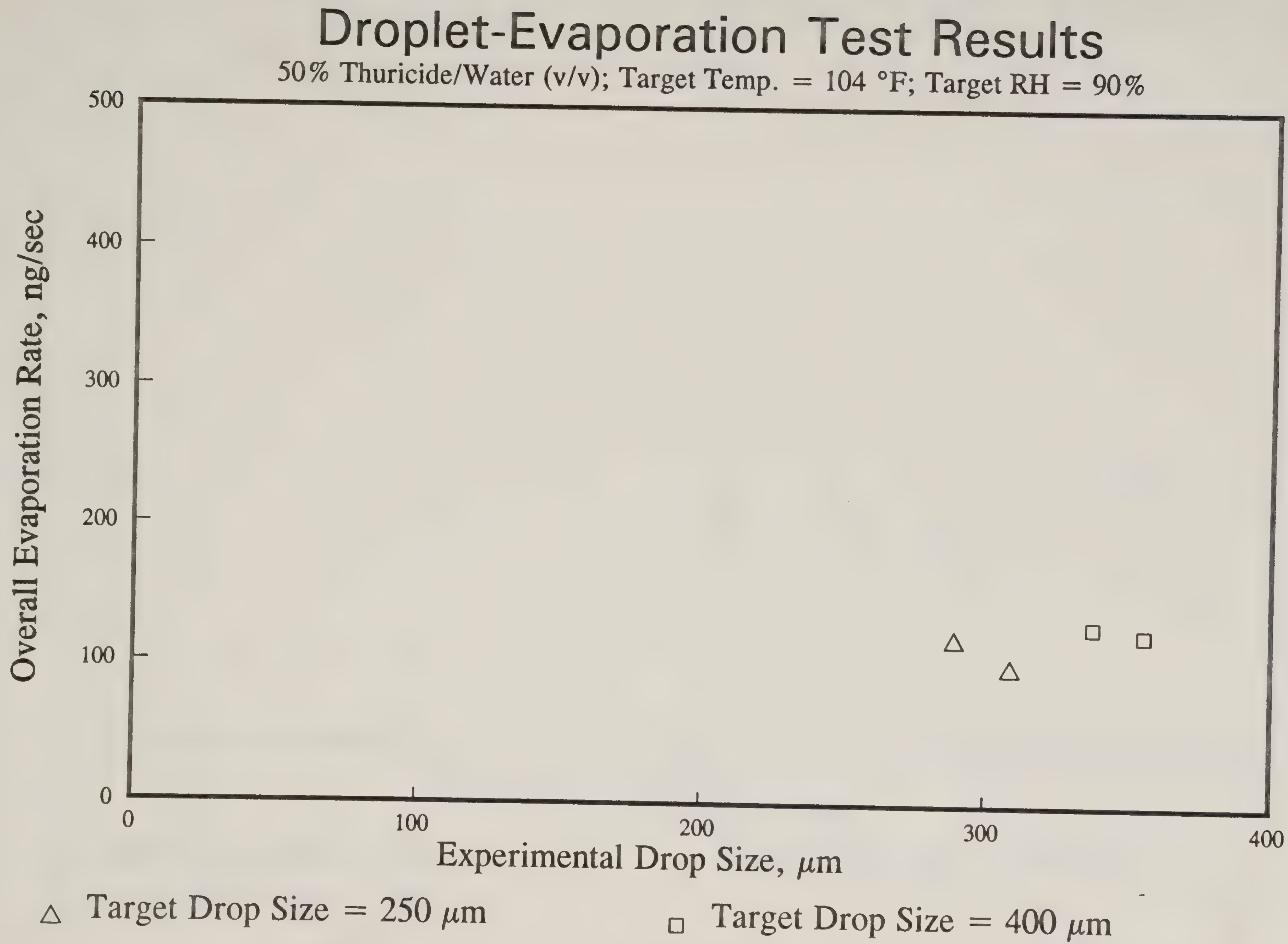

Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 104 °F; Target RH = 90%
Overall Evaporation Rate, ng/sec
0
100
200
300
400
500
0
100
200
300
400
Experimental Drop Size, μm
△ Target Drop Size = 250 μm
□ Target Drop Size = 400 μm

Figure F-22

Droplet-Evaporation Test Results

50% Thuricide/Water (v/v); Target Temp. = 59 °F; Target RH = 30%

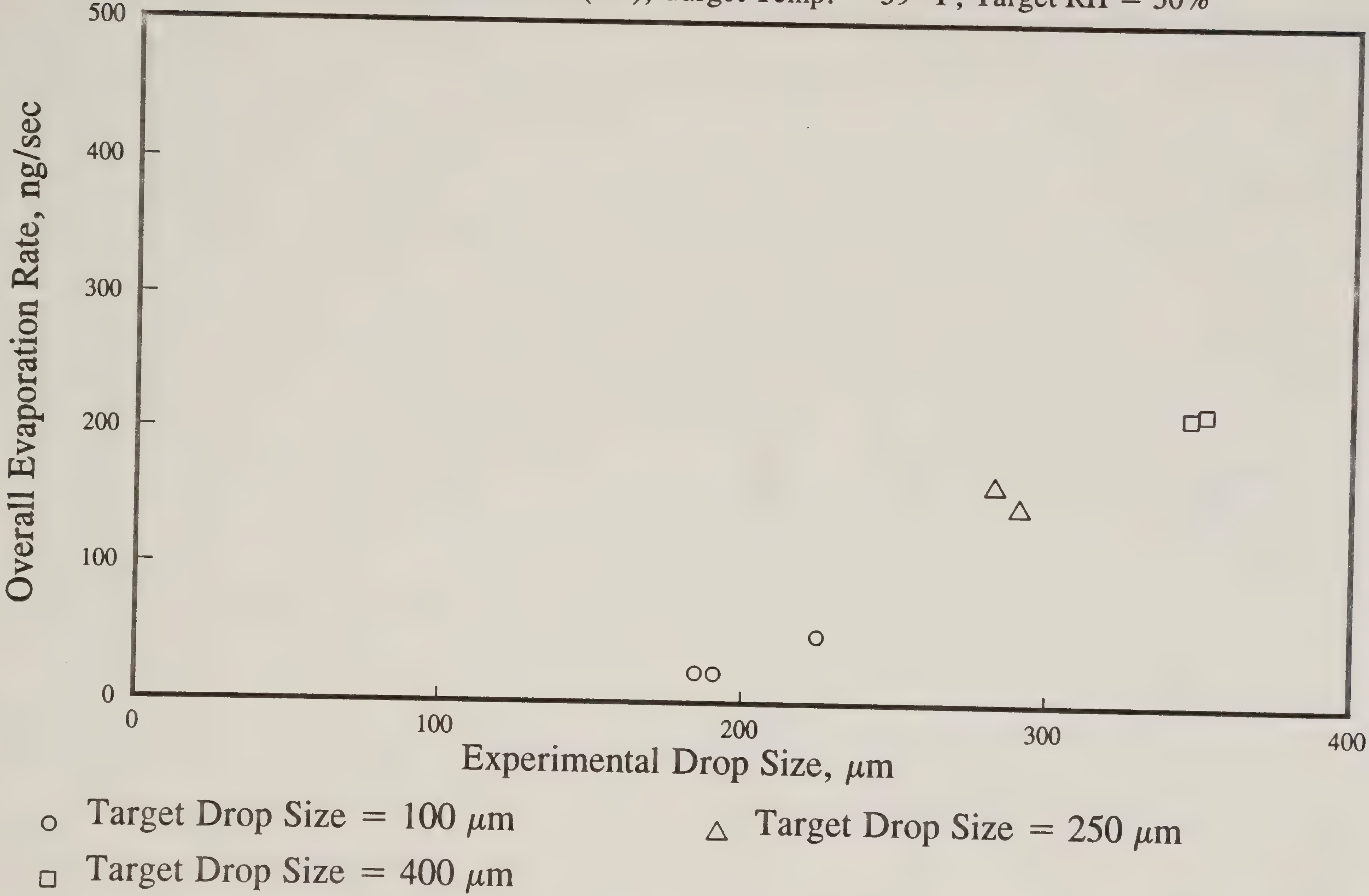
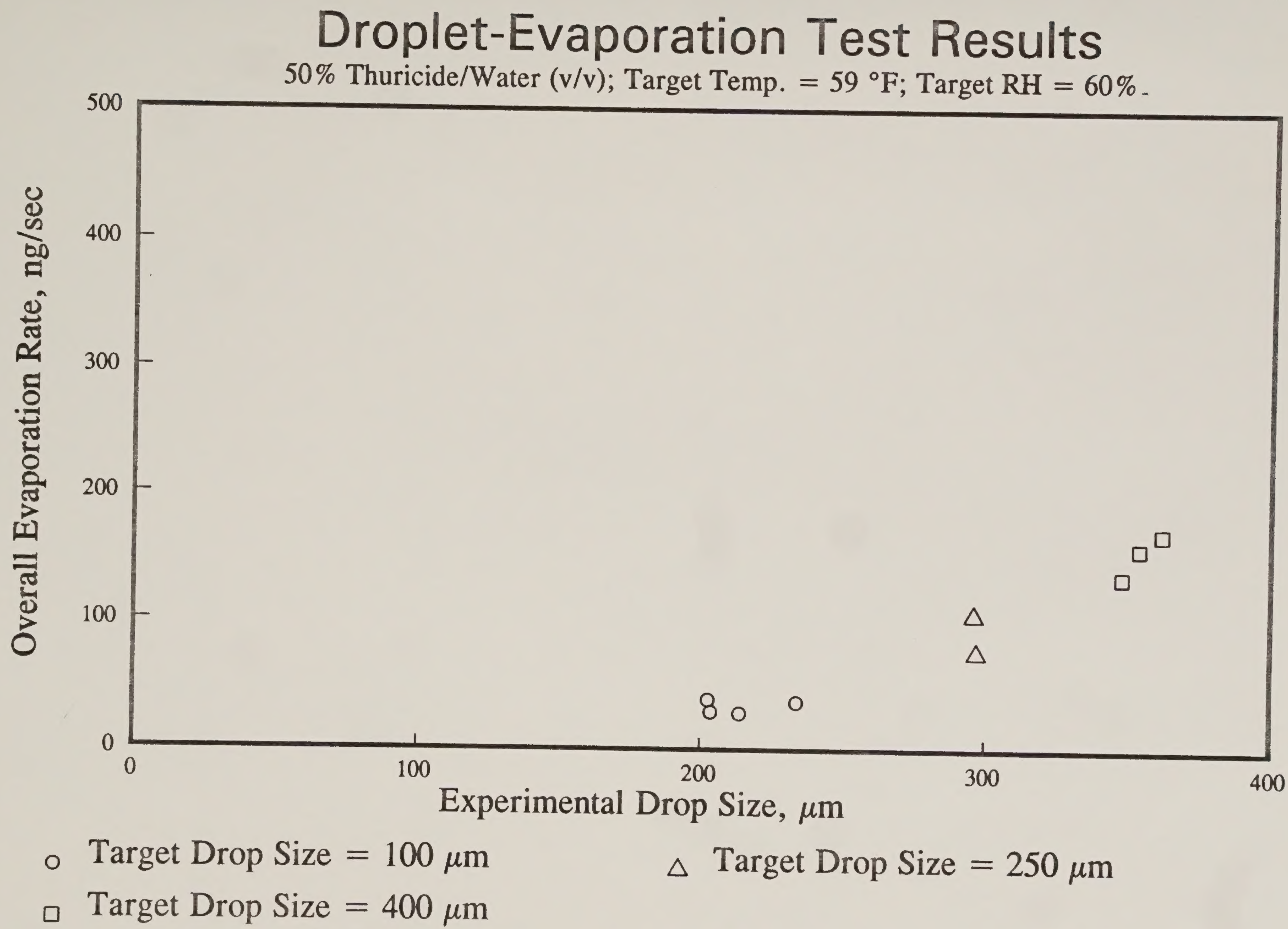


Figure F-23



Droplet-Evaporation Test Results
50% Thuricide/Water (v/v); Target Temp. = 59 °F; Target RH = 60%
Overall Evaporation Rate, ng/sec
500
400
300
200
100
0
0
100
200
300
400
Experimental Drop Size, μm
Target Drop Size = 100 μm
Target Drop Size = 250 μm
Target Drop Size = 400 μm

Figure F-24